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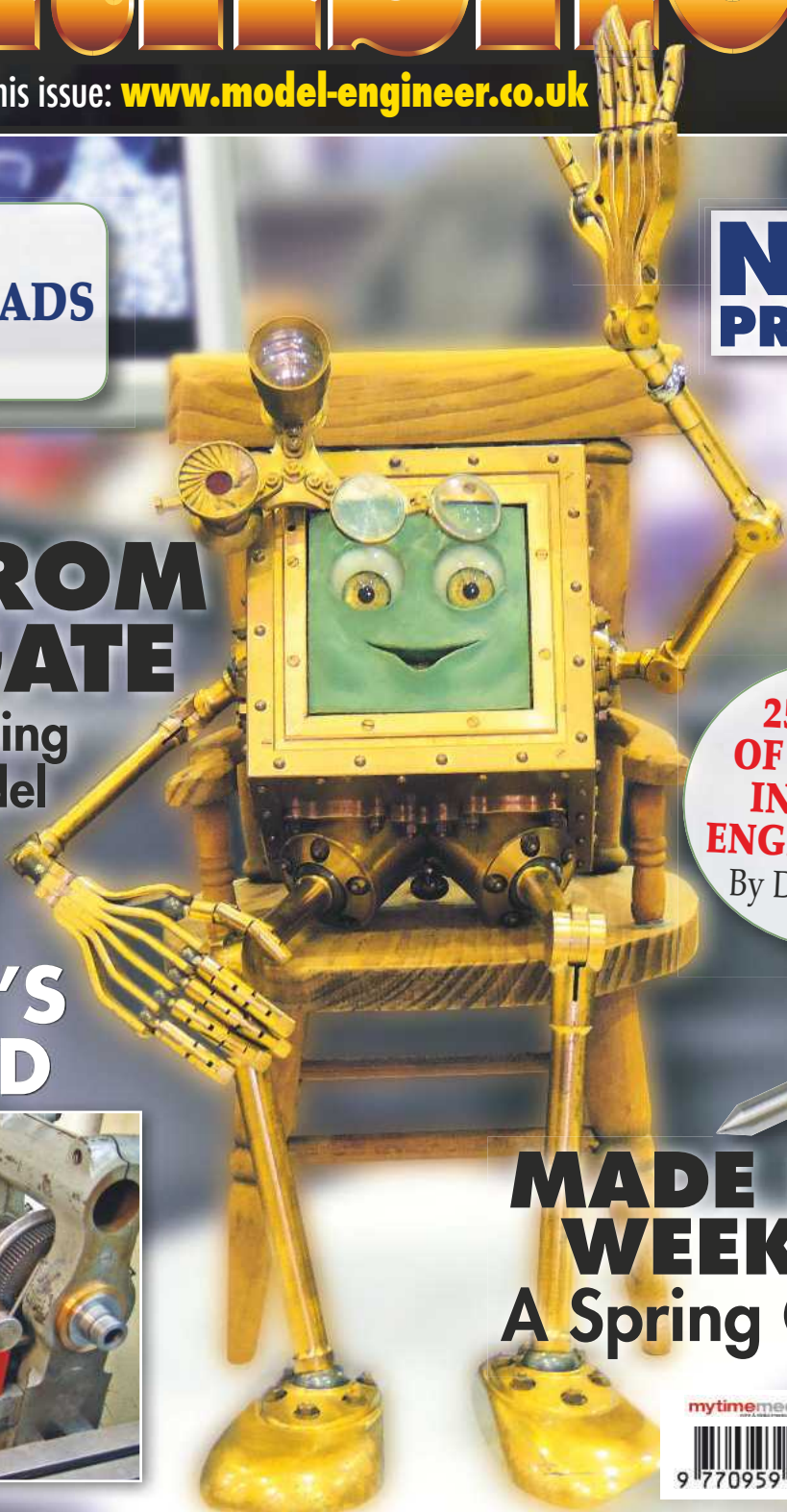
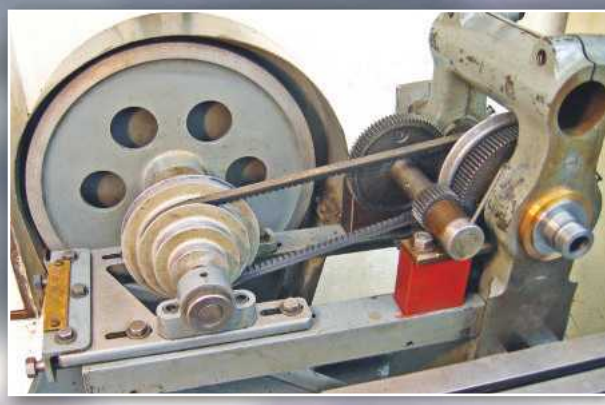
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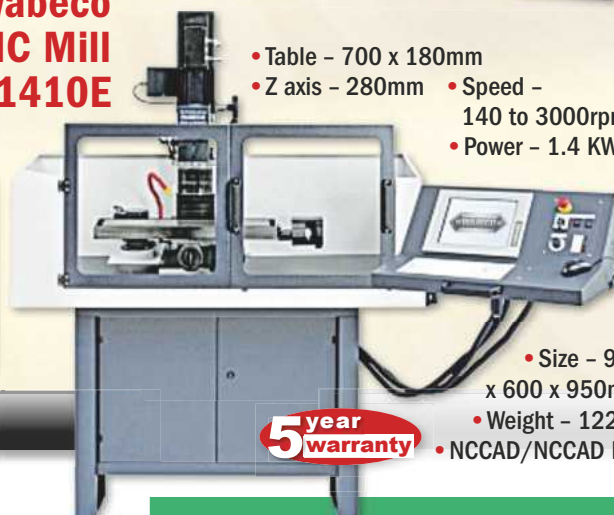
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EDITORIAL

Editor: Neil Wyatt

Tel: +44 (0)1689 869 912

Email: neil.wyatt@mytimemedia.com

PRODUCTION

Designer: Yvette Green

Illustrator: Grahame Chambers

Retouching: Brian Vickers

Ad Production: Robin Gray

ADVERTISING

Senior Account Manager: Duncan Armstrong

Email: duncan.armstrong@mytimemedia.com

Tel: 0844 848 5238

MARKETING & SUBSCRIPTIONS

Subscription Manager:

Kate Scott

MANAGEMENT

Head of Design & Production: Julie Miller

Group Advertising Manager: Rhona Bolger

Email: rhona.bolger@mytimemedia.com

Tel: 01689 869891

Chief Executive: Owen Davies

Chairman: Peter Harkness

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On the Editor's Bench



On My Bench

I'm ashamed to admit that I haven't been very active in my workshop for a few months, but I have been able to find a few opportunities to engage in another hobby – astronomy. Fortunately, I have found a few excuses to bring the two together, along with my interest in electronics. Although my telescope came with a very nice mount, the tripod left quite a lot to be desired in the stiffness department. Various actions including filling part of the legs with sand, adding extra clamps to the legs and solidly fixing the hinge blocks to the top of the legs have made a significant difference. I also got a chance to try out the aluminium welding wire I obtained at Harrogate, welding a simple brace plate to one of the tripod legs. I would do the other two legs, but for now the tripod seems to be behaving. The part of the upgrade that involved some accurate turning and threading was to make a swing-clear gearbox for a stepper motor and a control box. Anyone who has ever use a powerful telescope will recognise the urgency with which planets and stars want to slip out of the field of view. The 'right ascension drive' allows the scope to follow objects like the moon and planets around the sky at an appropriate speed. With a little pride, I present a couple of my pictures although they pale by comparison to what some other amateurs have



achieved. Saturn is currently due south around midnight, the final picture shows the Jupiter's moon Io casting its shadow on the giant planet.

A Tall Story

I rather like Laurie Leonard's coolant pliers in this issue, although I don't use flood coolant in my workshop. My teenage daughter has a giraffe, Georgie, who she has had since she was a baby. Several years ago, Georgie suffered a serious injury and in my battle to heal him I discovered he has an 'endoskeleton' made of coolant hose. All my efforts to cure his cricked neck failed, and now he has a 'Barry Sheene' style steel rod within his neck 'vertebrae'. My recommendation is that all zoo vets obtain a pair of Laurie's pliers!

Photo Competition

Well, what a turn up for the books! Either my appeal went straight to the heart of many readers, or everyone was saving up their entries for the last minute! Although I hope to get the judging done before the next issue is finalised, I may need to contact a few entrants for mugshots or short descriptions of their pictures. This means that a special article featuring the winners and runners should appear in issue 232!

TWENTY-FIVE YEARS

As most readers will be aware by now, 2015 marks the Silver Anniversary of our first issue in the Summer of 1990. As MEW is now a four-weekly, rather than quarterly publication the exact anniversary is debatable! Rather than worrying about this, we are marking the event in a number of ways, the most significant of which is the collectable 25 Years of Model Engineers' Workshop special. You should be able to get a copy of this at your local newsagent or WH Smiths, but if not there's an order form in this issue or visit www.myhobbystore.co.uk and put '25 years' into the search box.

This month we have a special article by Dave Fenner, one of our past editors, who takes a look at how the hobby has changed in those 25 years. I hope you agree that he offers an interesting perspective. Looking back at early issues I think my over-riding impression is how little prices, new or second-hand, have changed since the 1990s. Clearly this is good news for anyone setting up a workshop but it does highlight the challenges facing the dedicated suppliers we rely on to support our hobby.



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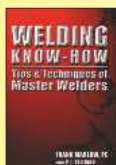
An exceptionally good modern book on basic engineering practice. Vast numbers of drawings of set-ups, rather than photographs and, as the text is based on 'Questions and Answers', it is very much to the point; it is also strong where practices have changed. Whilst American, a whole host of manufacturers have been consulted in its preparation, including Colchester and Myford, and variations in practice between countries are covered. The spread of this book is well illustrated by the Chapters: *Measurement Tools, Layout & Job Planning, Basic Hand Tools, Filing & Sawing, Grinding, Reaming, Broaching & Lapping, Drills & Drilling Operations, Threads & Threading, Turning Operations, Milling Operations, Fastening Methods, Machine Shop Steel, Metallurgy, Safety & Good Shop Practices, Other Shop Know-how and Sharpening Steel Lathe Tools*. This isn't cheap, but the quality of the information is priceless, especially if you have just shelled out large sums of money for machinery. For the newcomer this book will be invaluable - even if you have been in the workshop man-and-boy you will much of it useful. Highly recommended - as if you couldn't guess that. 518 pages. 497 drawings, plus tables. Paperback.



Machine Shop KNOW-HOW

Marlow • £44.60

Every now and again a book crosses the desk which rocks our socks off (to use a modern expression). 'Machine Shop Essentials' (above) was one, and if it is possible, this is even better. Here are 'The Tips and Techniques of Master Mechanics', and the chapter titles will give a good idea of this book's scope: *Setting Up Shop, Metals, Alloys, Oils & Hardness Testing, Tapers, Dowel Pins, Fasteners & Key Concepts, Filing & Grinding, Drilling, Reaming & Tapping, Bandsaws, Lathes, Milling Machines and Machine Shop Problem Solving*. No photographs, but nearly 600 specially drawn drawings compliment the very clear explanations. As with the earlier volume this really will be invaluable to the newcomer to model engineering, but we are certain even a highly experienced engineer will find valuable hints, tips and ideas in this book's 520 pages. Larger format paperback.



Welding Know-How

Marlow • £44.60

We have offered a number of welding books - all good in their different ways, but here is a book which covers every aspect of soldering, brazing, welding and cutting by electrical, gas and combined means. It comes from Frank Marlow, author of two books above, and anyone who has either of these will know what to expect; wall to wall information, backed up by numerous very clear drawings, rather than photographs. If you buy just one book on joining metal, this is the one! 544 pages. Over 500 line drawings. Paperback.



Advanced Machine Work

1925 • Smith • £31.55

Originally "prepared for students in technical, manual training, and trade schools and for the apprentice and the machinist in the shop". The beginner may find this book a bit heavy going, until they have done some machining and outgrown first books, but within the 800 pages is an incredible amount of information on machining operations of all sorts - this title comes nearer to "containing it all" than any other book we know! 800 pages, 1000s of illustrations, tables etc. Hardbound.



Machine Shop Methods

1950 • Milne • £18.85

Dave Gingery reckoned this was the best beginner's machine-work book he had seen, and it certainly is good. The majority of the chapters are concerned with using the lathe, but others cover the drilling machine, the shaper, the milling machine and the grinder. And there are other chapters on holding the workpiece, useful tools and fixtures - full drawings for a large number of items, gears and gear cutting, cutting speed and finish, accuracy and materials. The illustrations (all drawings) are very clear and the text is concise and to the point. 376 very heavily illustrated pages. Paperback.



Metal Turning on the Lathe

Clark • £18.19

Very good and clear book for the beginner who wants to make a start in lathe work. Written by a former editor of *Model Engineers Workshop*, it goes from thoughts on buying that first lathe to installing it, cutting tool principles, how to sharpen and hold tools, workholding, turning between centres and on the faceplate, collets and mandrels, right up to taps, dies and screwcutting. Good text, numerous excellent colour photographs of actions and set-ups, and some B&W drawings. 109 page hardback.



Milling (David Clark)

Clark • £18.19

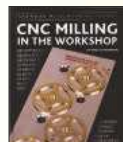
Another very good and clear book for the beginner who wants to make a start in milling. As well as providing guidance of what sort of milling machine to buy, the installing and setting up of the machine itself is covered, as are the principles involved, the various cutters and how and when to use them, setting up work, work holding, using rotary tables and dividing heads etc. Hard to beat as a guide for the beginner. 110 pages, numerous colour photographs, sketches and drawings. Hardbound.



CAD for the Workshop

Hughes • £18.19

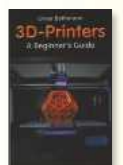
"... this practical guide gives a thorough introduction to the technology and how to greatly enhance design and manufacture in the workshop". It certainly is very informative, and a good starting point if you wish to learn about computer aided design, in both two and three dimensional forms. 112 pages. 210 colour illustrations. Hardback.



CNC Milling in the Workshop

Bowman • £18.19

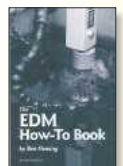
CNC control of milling machines is now available in a size that means they can be used in the smallest of workshops, allowing the user to be more ambitious in producing different items, and especially in the production of multiple items. The author takes a practical approach to the different aspects of CNC milling work showing you how to make full use of your machine. A word of caution:- this book is not aimed at the complete beginner; it makes the assumption that you have a CNC enabled milling machine which is set up, and have a basic idea as to what you are doing on a computer. If this is the case, this book is a must-have tool. Included within the book is a guide to the major CAD/CAM/CNC software such as Mach3, LinuxCNC and Vectric packages, as well as a large number of practical projects in each section; we highly recommend this book if you want to go electronic. 144 pages profusely illustrated with loads of colour photographs, diagrams, charts and so on. Hardbound.



3D-Printers A Beginner's Guide

Bothmann • £12.05

3D Printers are already revolutionising all forms of engineering and, with printer prices coming down rapidly, they are coming in to the realm of the model engineer; purists may look at them aghast, but they are here, so why not learn how to use them? This book is a good starting point, as it gives a wide overview of the process, the hardware and software required, and gives tips and tricks for the practical application of this exciting technology. Be in on the ground floor! 126 pages, 175 colour illustrations. Paperback.



The EDM How-To Book

Fleming • £22.05

The strength of this book lies in the care the author takes explaining how to deal with the electronics and electrics, on the assumption that there are likely to be more engineers with minimal electronics experience, rather than the other way round, building this machine - which isn't to say that the mechanical bits aren't also good. EDMs are very useful machines and making one is an interesting process, which produces something you will end up wondering how you survived before you had it. This is an American book, so the voltages differ from most norms, but the author assures us the adjustments for higher mains voltages are minor. 168 page paperback full of drawings, diagrams and photos.



Build a Pulse EDM Machine ~ The Next Generation

Fleming • £28.05

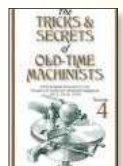
The EDM book above has been a consistent seller, and if you just want an EDM to remove the occasional broken tap or drill, then it is just the job. But if you want a machine capable of much finer work, which can be used to burn reverse artistic images into tool steel for moulds or the like, then you need a Pulse EDM, in which the spark is controlled by a timer and power Mosfets. Normally only available as very expensive machines, here genius Ben Fleming describes how you can make your own Pulse EDM at reasonable cost. You will have to have some electronics knowledge (or acquire it), as well as mechanical engineering, but this is a great project. 128 page large format paperback, full of drawings, schematics and B&W photographs.



How I Pour Babbitt Bearings

Gingery • £ 8.65

In this book Vince Gingery gives a brief look at this type of bearing and then gets down to the business of explaining how to clean old bearings, re-metal them and prepare them for re-fitting. Usual clear and concise Gingery information. 43 well produced pages. 59 photos and drawings. Paperback.



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David Piddington designed this robust accessory, an ideal subject for those seeking to make a sound workshop tool from castings.



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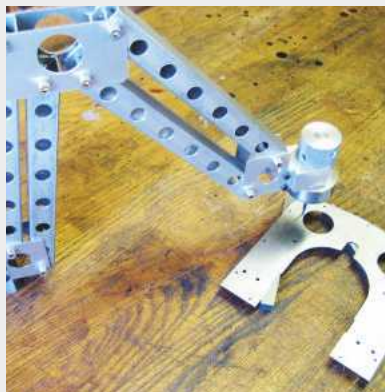
See page 49 for details.

Coming up...

in the August issue

MAKE A CANTILEVER TAPPING TOOL

We bring you full details of a cantilever based tapping tool from Mogens Killde, designed with his usual attention to detail.



PLUS Paul Lousick details his Morse-taper removal tool, the new Warco WM250V and its milling attachment are reviewed and Howard Lewis reports on a gaggle of vintage lathes seen at the Spalding Show.

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ON THE COVER



Cuborg, the mascot of Eccentric Engineering, made a rare UK appearance at the Harrogate, and found time to send his greetings to MEW readers. See what else was happening on page 34.



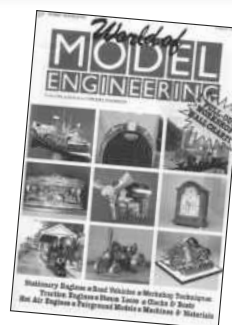
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The World of Model Engineering

Take a look at the magazine reprints in the features section of the website. They include several specials printed under the series title *The World of Model Engineering* – each is downloadable for free in PDF format.



Removing Broken Taps

It's the hot topic of the season, everyone seems to be breaking off taps in castings and stainless steel. There are several; threads looking at a range of solutions from spark erosion to making a special core drill. Take a look and benefit from a range of experiences.

Some of the other live topics on the forum include:

- 3D printing for a Threshing Drum – impressive patterns - and castings.
- EMG-12 Endmill Re-sharpening Module – with around 22,000 views, no-one can say this machine hasn't sparked the interest of readers!
- ML7 Repairs and Renovation – What does and doesn't need tweaking on an older machine?
- Rotary Laser Centre Finder – progress with a shop-made device.
- Grinding a Masonry Drill for Steel – a cheap way to get a carbide drill for emergency use?

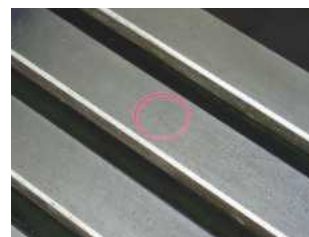
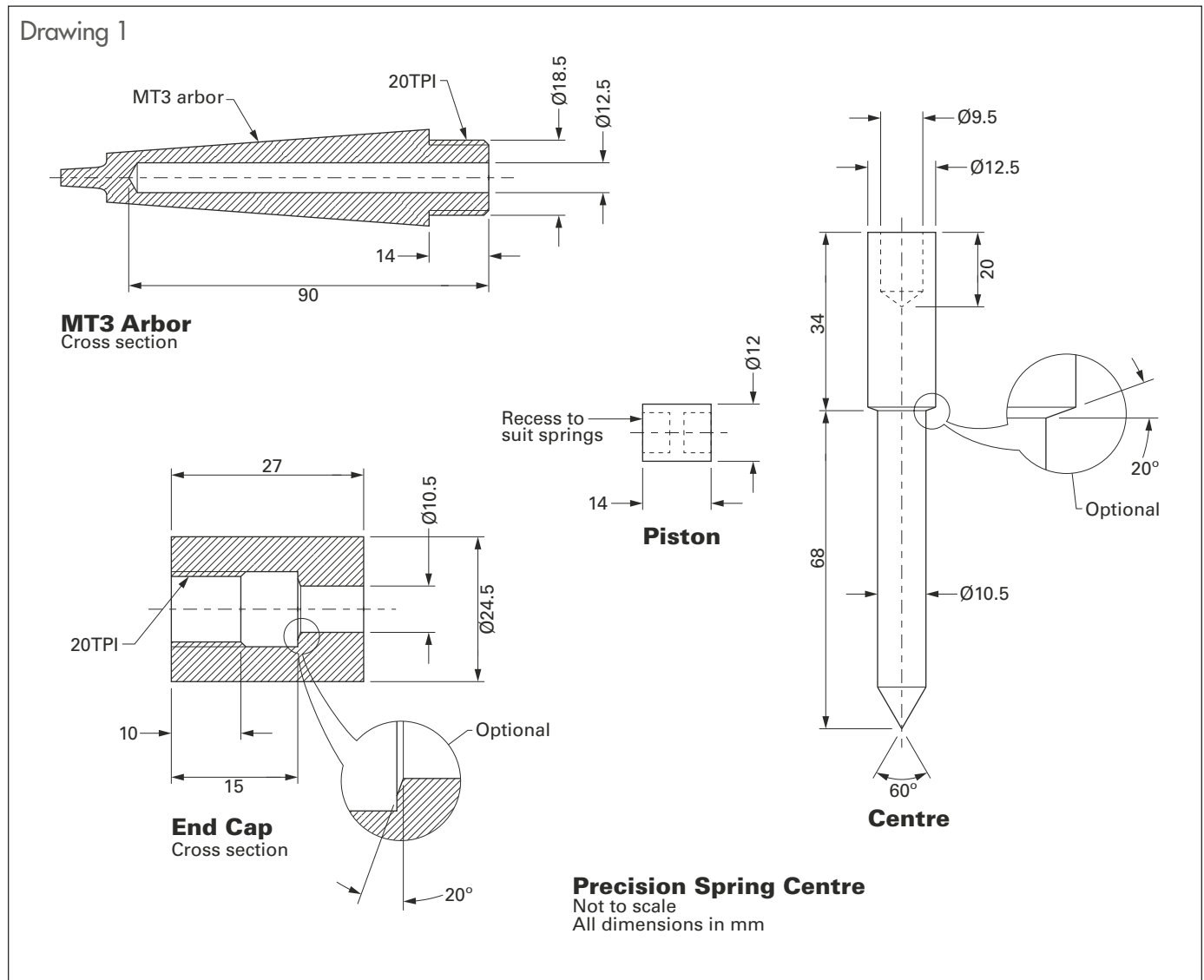


Photo: Vic Russell.

A Spring Centre



Darren Conway details a useful accessory with several uses.



There are plenty of designs for spring centres to be found on the Internet but the ones I located had a limited range of movement or the centre would clearly have significant backlash. In my experience the extra time and effort required to make a precision tool is often less than the time required to compensate for any lack of precision when applied to a work piece. Furthermore, the extra time required to improve precision is a one-off investment. The benefits of that investment are repaid every time the tool is used. In addition the extra confidence gained from using accurate and well made tools allows focus to be maintained on the job at hand rather than worrying about any tooling deficiencies. Overall, the benefits justify making the extra effort required to design and produce quality

tools. With that philosophy in mind, I set about to make the precision spring centre presented here. I had managed without one but I had managed without one enough times to justify making one.

Spring centres are most commonly used in the tailstock to steady taps. Ideally a spring centre should have a range of movement that is as deep as the hole to be threaded. The spring centre is also useful to locate a centre mark when drilling on the mill-drill. A standard centre is often too short to be substituted for a drill bit without raising or lowering the mill head. On typical mill-drills, the mill head is not accurately located on the cylindrical column and can rotate when raised or lowered. A long spring centre can be used to centre the mill head over a point within the reach of the mill head quill range of motion.

Requirements Defined

The broad design goal was to produce a precision spring centre but to this I added the requirements to have an extended range of movement with a reasonably constant spring force. In addition, I wanted a design that would be compact to avoid using up too much of the distance between the lathe centres or under the mill head. I started by reviewing designs I could find on the Internet to incorporate the best features into my own design.

Many of the designs reviewed had a short range of movement and used a short high rate spring. A long range of movement can only make the spring centre more convenient to use especially when tap threading deep holes. Maintaining a reasonably constant force on the centre will also make the tool easier

to use. In this case the constant force requirement was very loose because it would be impractical and unnecessary to achieve a truly constant force across the range of movement.

Both of my lathes and my milling machine have Morse taper 3 holders so using this size taper was a given requirement. The design presented here can easily be modified to suit the machines and available materials in your workshop.

Design

A surprising number of iterations were necessary to arrive at the final design.

The final design (**Drawing 1**) achieved all the requirements by applying a Russian doll approach. Each major part fits inside another. The centre fits down into the Morse taper arbor. The spring fits inside the arbor and may partly fit inside the end of the centre. The result is a design for precision spring centre with a good range of movement within a compact space.

The design included a precision bore down the centre of the Morse taper arbor. This bore doesn't need to be precise for the entire depth because the compressed spring will stop the centre part way down the bore. This is significant because this design made it relatively easy to accurately finish part of the bore depth.

The spring force can be made more constant across the range of movement by using a long spring and also by pre-loading the spring. Spring force is proportional to the spring displacement and rate. In simple terms, a long spring will show less variation in force than a short spring for a given range of displacement. Pre-loading the spring effectively squeezes a longer spring into a smaller length. This also ensures that spring force is available even when the spring centre is fully extended.

The end cap is a multi-function component that keeps the spring centred and keeps the moving parts in their proper place. It also effectively seals out dust and other contamination. The end cap was designed to simply screw into place. It was designed with a 20TPI thread pitch because it was a convenient size and there was no need to conform to any specific thread standard. Any reasonably similar thread pitch would be suitable.

The spring centre is stepped to ensure it is retained by the end cap. The shoulder on the centre that strikes the end cap was chamfered to reduce the risk of a burr building up over time and jamming the centre. The screw-on end cap and the shouldered centre produce a tool with a clean snag free shape.

The final design is shown in **photo 1**. The Russian doll approach produced a compact and accurate spring centre design that met the defined requirements. The next stage was to ensure that the tool was made accurately.

Machining Sequence

The machining operations were carefully sequenced to eliminate errors between the key features and components of the spring centre. The end cap was made first. It was completed with the exception of the hole down the middle for the spring centre. Next the Morse taper 3 arbor was



Assembled spring centre. INSET: D-bit reamer.

completed without removing it from the lathe spindle. Finally, the end cap was fitted to the arbor (still held in the spindle) and the hole in the end cap was bored and finished. In this way all machined surfaces were accurately located without run-out.

The only potential source of error that could not be compensated for was any run out errors in the lathe spindle Morse taper. Burrs and contamination are the most likely causes. I cleaned out the lathe spindle with a Morse taper reamer followed by a rag soaked in thinners. These simple precautions minimised any run out errors between the lathe spindle and the Morse taper arbor.

End Cap

The end cap was made of brake die alloy steel for durability and wear resistance. The cap was bored, internally threaded and faced in one operation. This provided a thread combined with an accurate register, just like a threaded lathe spindle. The end cap was then parted-off to length without drilling a hole down the middle for the centre.

Adapting the arbor

Rather than make a Morse taper, I decided to start off with a cheap Chinese made Morse taper 3 to J6 drill taper arbor. These are made to mount drill chucks onto a Morse taper. The cost of these arbors is less than buying a piece of bar steel. Starting with a mass produced arbor significantly reduced the work required to complete the precision spring centre.

Attempts to drill out the MT3 arbor failed. I found very hard spots that simply destroyed the drill bits. Clearly some form of heat treatment was needed to bring the hardness down to a workable level. I don't have a furnace so I simply baked the MT3 centre in the oven at full temperature for 30 minutes. I then left the MT3 arbor in the oven to cool down for a few hours. The result was an evenly tempered and

moderately hard metal that was soft enough to machine. Once tempered, steel achieved homogeneous condition with no hard spots. The steel was easy to drill or turn and produced a good finish. I then had no difficulty in drilling out the arbor.

The next step was to finish the hole in the arbor. A drilled hole is not smooth or accurate enough to be considered a precision operation. Boring a hole of the depth was impractical. I needed a suitable reamer to accurately finish the hole to at least 75mm depth. The hole only needed to be accurate to the depth that the centre could reach. I don't have a large range of reamers and purchasing one was beyond economic justification. I decided to make a D-bit reamer.

The arbor was mounted in the lathe spindle MT3 taper and the exposed J6 taper was modified to produce a cylindrical section. This was then threaded to match the internal thread of the end cap. Grease was applied to the threads before screwing on the end cap to prevent the end cap jamming on the thread. With the arbor still held in the lathe spindle and the end cap fitted to the arbor, the final machining operation was completed on the end cap. The hole for the centre was drilled and then finished with a miniature boring bar.

Making a D-Bit

Attempts to make a D-bit from hardened steel ended up in the waste bin. The hardened bit wasn't hard enough to cut the Morse taper arbor. The basic home heat treatment process marred the finish of the reamer which then affected the finish of the reamed hole. I then obtained a round piece of HSS 4 inches long and 0.5 inch diameter. This didn't need heat treatment and had a good finish.

I ground the HSS piece to make a standard D-bit reamer shown in **photo 2**. In addition, the middle section of the D-bit reamer was ground to provide some relief to reduce friction against the bore of the

hole. The relief was ground by hand on the bench grinder. The cutting edge was also ground by hand to within about .025mm of the finished size. I then used a flat grinding stone to get to the final size. From there the cutting edge was honed and polished using grinding paste laid on a piece of thick copper. This produces a very sharp and smooth cutting edge which in turn produces an exceptionally smooth finish.

I have found with past experience that any paper backed abrasive doesn't work well for honing tool bits because the paper tends to deform along the edge of the tool. This slight rounding near the edge creates a small zone of negative rake or clearance at the cutting edge. The tool may look and feel sharp but it doesn't cut well. Copper or cast iron will hold abrasive paste and won't deform. With little effort, a mirror finished sharp cutting edge is achieved.

When using a D-bit, only a light depth of cut should be taken. The depth of cut should be just enough to remove the surface marks left by the drill bit. I held the D-bit in an ER32 collet chuck mounted on the tail stock as shown in **photo 3**. The arbor was still held in the spindle Morse taper. A very slow speed and fast feed was applied to the D-bit reamer. A good quality cutting oil was used to minimise friction and improve surface finish. Swarf was cleared often to avoid recutting chips or jamming chips between the reamer and the workpiece. It was only necessary to ream to about 75mm depth because the centre is prevented from reaching the bottom of the hole by the springs.

The finished arbor is shown alongside the original MT3 item in **photo 4**. The simple heat treatment changed to colour of the arbor.

Centre

The centre is straight forward to make. The centre was made from high quality alloy steel that is resistant to wear and corrosion. The spring centre was turned between centres to ensure that the cylindrical sections were not tapered. The two diameters must be accurately turned to size to be a close sliding fit to the bores they pass through. The shoulder between the two diameters should be at a 30 degree slope to help prevent a burr forming as a result of the centre impacts when allowed to fully extend. The inside edge of the end cap should also be chamfered to match. A small flat was filed down the larger diameter to allow air to leak past as the centre is moved up and down the bore.

The centre was then accurately centred in a four jaw chuck before turning the point. The tool bit height must be precisely set to produce a straight sided cone.

The large end of the centre was designed to allow it to be drilled out for the spring. This would have made it possible to use a spring with an unloaded length of up to about 200mm. Some experimentation showed that this wasn't necessary but the design still allows for it.

Spring Making

I tried making springs from piano wire available from hobby stores as described on many web sites. I wound the springs and then heat treated them to removed



D-bit in use.



MT3 arbor before and after.

internal stresses. They worked but no where near as well as factory made springs. I suspect that the type and quality of piano wire steel isn't entirely suitable for spring making. I finally settled on throttle springs normally found on the carburettor of a small engine, specifically the Yamaha KT100 kart racing engine. These springs are readily available at any good kart shop but any seller of small engine parts should be able to supply similar springs.

Individually, these springs are too short so a pair of them were fitted end to end. The two carburettor springs were separated by a sloppy piston. The piston keeps the springs in their proper place. The piston was intentionally made with a sloppy fit in the bore to prevent jamming. This solution worked well. In particular, the piston holds the springs in the centre of the bore and keeps them away from the bore to any prevent wear.

Assembly

The components of the spring centre are shown in **photo 5**. Grease was smeared onto the internal parts of the spring centre to ensure smooth operation and protect against corrosion. The springs, piston and centre were inserted before the end cap was screwed into place.

Conclusion

This would make a good project for someone learning to use a lathe. It includes the basic machining operations a lathe is used for. A spring centre is one of those tools that just makes certain operations a lot easier. The most common application of a spring centre is to align a tap in the lathe or milling machine as seen in **photo 6**. The spring centre presented here is regularly used and has proven to be accurate and rigid. ■



The spring centre 'exploded'.



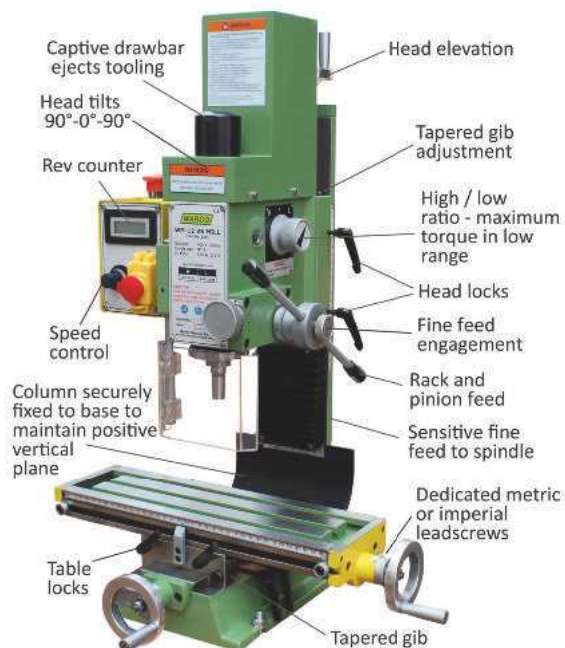
The spring centre in use.

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A tee slot faceplate for an Asian Mini-lathe



Michael Cox makes a useful accessory applicable to many hobby lathes.

Unlike most smaller lathes the Asian mini-lathe spindle terminates in a flange rather than a screwed nose. The lathe chuck is bolted to the flange. Registration is ensured by a small shoulder on the flange that fits into a recess at the back of the chuck. This system works well and it has the advantage that the lathe can be run in forward or reverse without any possibility of the chuck unscrewing, as can happen with chucks attached to the spindle via a screwed nose. The downside of a flanged spindle only becomes apparent when the flange is used in conjunction with a standard faceplate. The presence of the flange means that the slots in the faceplate for clamping screws are short and cannot approach the centre of the faceplate, see **photo 1**. This makes clamping small work pieces to the faceplate very difficult.



The standard faceplate.

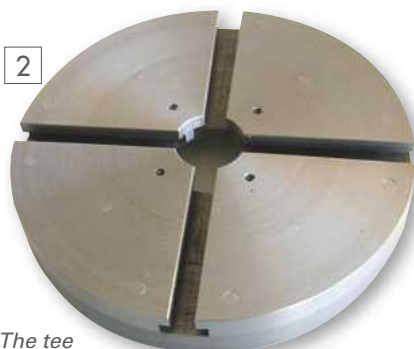
An obvious solution to this problem was to make a tee slot faceplate. The tee slots can run all the way from the edge of the faceplate to the centre that would allow much better possibilities for clamping small work pieces. At the time when I was considering this possibility I did not have a mill so milling tee slots was not an option. Instead, I fabricated the tee slots by using a laminated construction. **Photograph 2** shows the completed tee slot faceplate.

Construction

Photograph 3 shows the edge of the finished faceplate. It is built up from three layers of metal. The bottom layer, the base plate, is made from 14mm cast iron. Above the base plate are two layers of 5mm hot rolled steel plates cut to form the tee slots. The whole construction is held together with screws, see **photo 4**. The screws are M5 except for the four closest to the centre, which are M4.

The base plate

This was machined from a 2kg dumbbell weight. The dumbbell weight was part of a weight training kit purchased from Aldi. The kit contained two 1kg weights, two 2kg weights and a substantial bar on which they could be assembled and it cost less than £10. It was such good value in terms of weight of metal/£ I bought it even though, at the time, I did not know what I was going to do with it. Most of the metal has now been repurposed!



The tee slot faceplate.

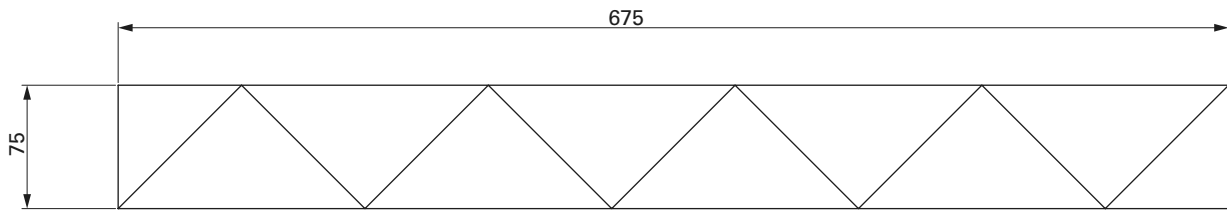


The tee slot faceplate- side view.



The tee slot faceplate- underside.

Fig. 1

**The Cutting Pattern For The Tee Slot Pieces**

The problem with dumbbell weights is mounting them securely on the lathe for machining. I chucked the weight using the normal jaws of the three jaw chuck in the central hole in the weight. Unfortunately the tip of the jaws only engages about 6mm into the hole. It was therefore necessary to also use a drawbar through the spindle ensure that the weight did not fall off the chuck. Once the weight was mounted securely then the part of weight between the central boss and the rim was faced. This part of the weight carries raised lettering so the cut is intermittent until the raised lettering is removed and it was necessary to take light cuts. Once this section of the weight had been faced off completely then a circle 66mm diameter was scribed onto the surface using a pointed lathe tool. Using a small block between the chuck jaws and the lathe bed the weight was indexed round and the 66mm circle cross scribed at 120 degree intervals. The weight was then removed from the lathe and the three intersections with the circle were centre punched. The weight was drilled at the centre punch marks with a 5mm drill and then each hole was tapped M6. Three 25mm studs were cut from threaded rod and screwed into the M6 holes from the machined face so that they just emerged on the other side. Three M6 nuts were selected that were the same thickness and these were screwed onto the studs to touch the machined face and then tightened.

In order to ensure accuracy of the register recess, nominal diameter 55mm, a plug gauge was made that was an accurate fit in the back of my four-jaw chuck. A piece of 2.5 inch round bar about 25mm long was chucked in the three jaw and faced and then turned down to about 55.5mm for a distance of 5mm. The diameter was reduced further in very small steps checking carefully after each cut the fit in the four jaw chuck. A tight sliding fit of the plug gauge in the chuck is required. Once a good fit was achieved the sharp leading edge was given a very slight chamfer.

The chuck was then removed from the lathe and the weight was fixed onto the spindle flange using the protruding studs. If necessary add additional packing washers or nuts so that the central boss of the weight is just clear of the spindle. The flange nuts were tightened down hard because it is important that the weight cannot move on the flange during machining the register recess. The un-machined side of the weight was faced. The rim of the weight was faced first and the minimum material was removed. The inner part of the weight was machined to remove the central boss and the raised

lettering leaving a machined surface. The register recess was cut using a very sharp knife tool mounted on the tool post almost parallel to the lathe axis. Cuts were made starting in the centre and finishing about 27mm from the centre to give a recess 54mm diameter. The recess was slowly deepened to a depth of 4mm. Small cuts were then taken from the periphery of the recess to enlarge the diameter until the plug gauge would just slide into the recess. After use the plug gauge should be carefully labelled, wrapped and stored since it can be used again if ever another spindle register has to be cut. The final operation with this set up is to bore the central hub to give a good machined finish. It is not necessary to bore the hub the whole depth since the bottom 2-3mm of the bore will be removed in a subsequent operation.

The weight was now removed from the spindle flange. The nuts locking the studs in position were then loosened. The studs were repositioned to protrude from the recess side of the weight and locked into position with a little Loctite on the threads.

The weight was remounted on the lathe spindle, ensuring that the register properly locates, and tightened down. The front was faced to remove the central boss and the rim and finally the edge was turned to a smooth diameter. The final diameter of the base plate was 150mm. A circle is scribed on the front face about 5mm in from the edge using a pointed lathe tool.

I have described the machining of the weight in some detail, however, I would caution that not all cast iron dumbbell weights machine well. Some are extremely hard (white cast iron) and resistant to machining whilst others are grey cast iron that machines very easily. It is not necessary to use a cast iron weight for the base plate and a piece of 8mm or 10mm hot rolled plate could be used. To mark out such a plate simply centre punch a piece of plate 150mm square in the middle and draw 66mm, 140 and 150mm circles. Mark the stud hole positions as described above and roughly trim off excess material from outside the 150mm circle using a hacksaw or bandsaw. The plate can then be faced, recessed and bored as previously described.

The tee slot pieces

The tee slot pieces are triangular and cut from 5 x 75mm hot rolled steel strip as shown in **fig 1**. Eight triangles are needed and these can all be cut from one piece of steel circa. 700mm long. This is a very simple operation to do on a bandsaw once the 45 degree angle has been set up. The angle was roughly set up using the

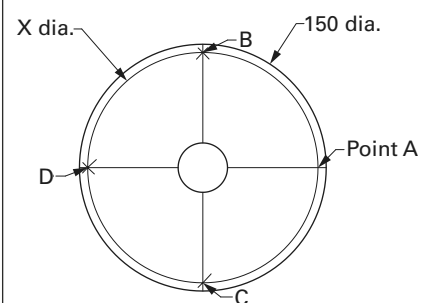
angular scale on the bandsaw. The angle was checked by sawing some wooden battening and checking the angle with a protractor. The batten was then turned over in the bandsaw and another piece cut off. The angle between the two bandsaw cut should 90 degrees. If it is not then readjust the set up slightly until the angle between two consecutive cuts is 90 degrees.

Once the angle is set correctly the steel strip was placed in the bandsaw vice and the end cut off. It was then turned over in the vice and a second cut taken. These operations were repeated until all eight pieces had been cut. The pieces were slightly chamfered along the cut edges to remove any burrs etc.

Assembly

The assembly of the tee slot piece onto the base plate must be done accurately. The first step is to mark two diametrical lines at right angles to each other onto the base plate. The intersection of the two lines must pass through the axis of rotation of the faceplate. To do this the faceplate was laid flat on the bench and covered with ink (I used a wide tip felt marker for this). On the circle scribed on the faceplate 5mm in from the periphery an indent was made using a centre punch: point A on **fig 2**. The diameter of the scribed circle was measured accurately using callipers. Suppose this diameter is Xmm. Now divide X by the square root of 2 (≈ 1.4142) to give a new number Y. A pair of dividers was set to give a radius of Y and with one point set in the centre punch indent two arcs were scribed to intercept the scribed circle in two places: points B and C in **Fig 2**. The intersections were then indented lightly with a centre punch. Using the same divider setting two more arcs were scribed using B and C as the centres.

Fig. 2

**Marking Out The Diametrical Lines**

These arcs intercept at point D in fig 2. A small indent is made at the intersection using a centre punch. A line was then scribed between the indents at point A and D using a steel rule and scribe. As a check the dividers were then centred on point D and two further arcs were scribed to cut the scribed circle at B and C. The circle and the arcs should intersect at the same point on the circle. A line was then scribed between the points B and C using a steel rule and scribe, again see fig 2.

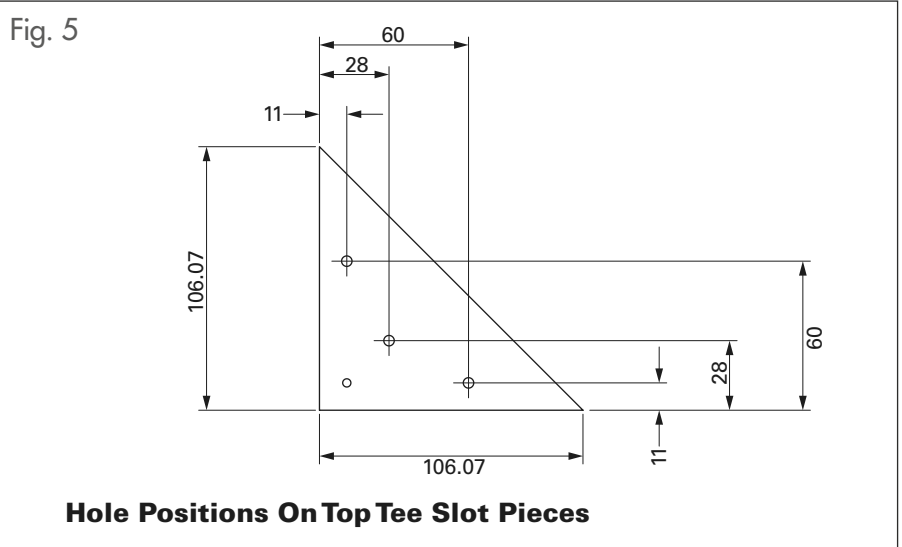
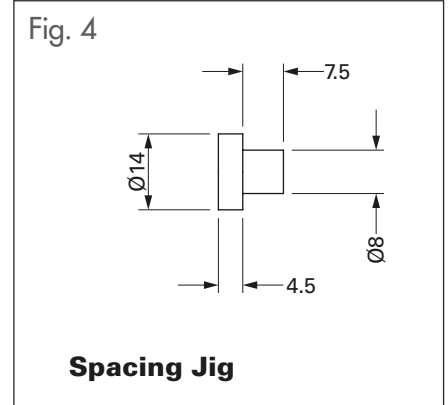
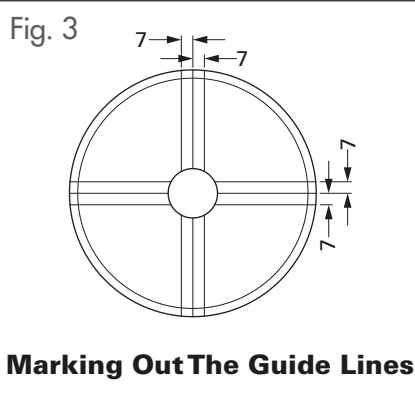
Parallel lines were scribed onto the baseplate as shown in **fig 3**. The lines were spaced 7mm from the diametrical lines. The scribing was done with some pressure so that they would be visible after the marking ink had been cleaned off the base plate.

To aid positioning of the tee slot pieces some small spacing jigs were made as shown in **fig 4**. These were turned from $\frac{5}{16}$ inch round steel stock. Three of these were made.

The base plate and four sets of the triangular tee slot pieces were then cleaned and degreased using white spirit and then lighter fluid. The tee slot pieces were laid out onto the base plate so that they just touched the scribed parallel lines, see **fig 6**. The spacing between the triangles was then checked using the spacing jig. Once satisfied that the layout was good then one triangle was removed and three drops of super glue (cyanoacrylate) were applied to the back and it was then replaced in position and the spacing checked once more with the jig. This procedure was repeated with the other three triangles and the assembly left for the adhesive to set.

Whilst the adhesive was setting the other four triangular pieces were marked out as shown in **fig 5**. Each hole's position was centre punched and drilled out 3mm. The holes were deburred.

The base plate was taken and two of the spacing jigs positioned in the slot between two of the bottom tee slot pieces; one near the centre and one near the periphery. The third jig was positioned in the middle of an adjacent slot. One of the drilled out top pieces was then positioned between the 8mm protruding part of the three jigs. Using a 3mm transfer punch the central hole of the top piece was spotted through to the base plate. The top piece was removed and the base plate was then drilled through at the marked position with a 5.0mm drill. The hole in the top piece was drilled out to 4.3 and tapped M5. It was then secured to the base plate using an M5 hex head screw and washer. This procedure was repeated for the other three top pieces. Once all four pieces were secured in position the alignment was checked. It should be possible to slide the spacing jigs along each slot. If this is not possible then open out each of the 5mm holes in the base plate to 5.5mm and then reassemble and adjust the position of the top plates until the spacing jigs will slide freely. The central 5mm screws were tightened down hard and 3mm holes were drilled through the bottom plates and base plate using the holes in the top pieces as a guide. A small centre punch dot was placed on each top tee slot piece to mark the outer face. One of the central 5mm screws was undone and the top plate removed. The two peripheral holes in the



base plate/bottom tee slot piece were then drilled out 5mm and the hole closest to the centre was drilled out 4mm. This hole nearest the centre was also countersunk on the recess side of the base plate. The peripheral holes in the top plate were drilled out 4.2mm and then tapped M5 and the hole at the apex was drilled out 3.3mm and tapped M4. After deburring all the holes, the top tee slot piece was re-assembled to the base plate, ensuring that the centre punch mark denoting the outer face was on the outside, and screwed into position using three M5 hex head screws and washers and one socket head countersunk M4 screw.

This procedure was repeated on the other three top pieces. It is important that only

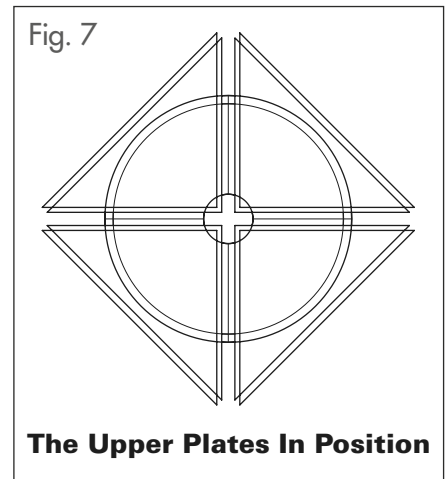
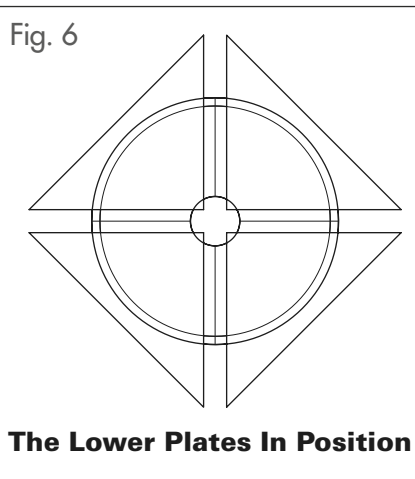
one of the top tee slot pieces is removed at a time since if they get put back in the wrong position it is unlikely that the tee slot spacings will be correct. Figure 6 shows a schematic of the finished assembly.

Finishing

With the assembly completed the finishing operations can be carried out.

All the screws were tightened down hard and any protruding bits were cut off from the front face using a hacksaw. Excess tee slot material was then cut away at right angles to the tee slots to form an octagonal shape as shown in **fig 7**.

The faceplate was then mounted on the lathe spindle flange. It was rotated by hand



It was such good value in terms of weight of metal/£ I bought it even though, at the time, I did not know what I was going to do with it.

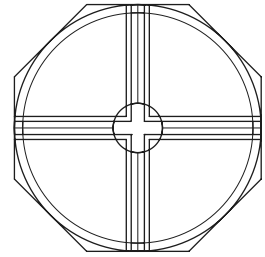
to ensure that it could rotate freely. If it hits the lathe bed then remove it from the spindle and cut more excess material from the tee slot pieces. The outside edge was then turned down taking small cuts at low speed until the tee slot pieces blended with the diameter of the baseplate, see **fig 8**. The edges were then chamfered. This whole operation takes a long time because of the small cuts and slow speed. However, if this operation is carried out more aggressively then the lathe will stall and fuses will blow.

The next operation was to face the front of the faceplate. Again this must be carried using very light cuts at slow speed to trim off first the remnants of the protruding screws and then to machine the faceplate surface.

The last operation was to use a boring bar to trim off the points of the triangles at the centre of the faceplate.

This faceplate has proved very useful and it is much more versatile than the standard faceplate supplied for the lathe. ■

Fig. 8



**After Trimming
Excess Material**

My 70-Year Old Apprentice

I am in my mid eighties, I have acquired an apprentice, he is in his seventies and is an antiques restorer. I marvel at the way he transforms a broken down piece of furniture, in particular his wood carving skills on the decorative parts are phenomenal. He had a problem with the collet on his router and his gardener said 'These better go and see *Mike the bike*'. There was a trivial solution.

Michael
Slatter
tells us a
workshop
tale.



Soon he wanted me to make odd metal bits and pieces for him, I told him he could do many of these himself if I gave him a bit of guidance. Looking around his place I found that he had a Colchester Master and a Myford that he had bought at auctions where they were out of context and therefore went cheaply. He had no idea how to use them but just let them gather dust, I got both of these running and took him under my wing. The first job he wanted to do was make some replica screws that hold old round folding tables together. They were mild steel with brass heads, modern triangular screw threads were not acceptable for the purists. They were rectangular threads 3.5 tpi two start ½ inch diameter. I set up the Myford and made a couple of silver steel taps in order to make the nuts and set him going. In his words he made enough for the current job and enough to keep his boys going for long after he was dead and gone, he wouldn't tell me how many scrappers he made.

I helped him make a lot of metal parts and he gradually gained confidence making brass knobs and sheet metal fittings.

The next project he tackled was a Norton gearbox for his Myford from a Hemmingway kit, there were several remakes during this and I did the milling on the castings for him. Since then he has bought a mill and apart from making

metal bits for his furniture he has also bought a 3 ½ inch gauge partly made Juliet and its castings. He has now made most of the machined parts, but I am always having to tell him 'now take it home and finish it' or 'that is not accurate enough, make another'.

Here is the point of my story, I have seen others dealing with the same problems. Many of these things were hammered home to me during my apprenticeship, others I have learnt the hard way.

- Study the drawing, is it first or third angle projection.
- Remember the old adage – measure twice cut once.
- A part is not finished until it is de-burred and cleaned up.
- Drill and tap holes to the correct measured depth, it is annoying to have to cut off one screw or re-tap a hole during assembly.
- Use a staking tool if possible when tapping a hole, otherwise ensure that it is square to the surface.
- Equispaced holes on a pcd are best done on a rotary table or with a dividing head before spotting through to the

mating part, then there is no problem on assembly in orienting the parts.

- Ensure that concentric surfaces are concentric, for instance a cylinder end with a spigot locating in the bore. When boring for the piston rod, drill an undersize hole, run through with a boring tool before further drilling or reaming.
- Don't rely on self centring chucks except when using soft jaws, turn a stump mandrel to hold it and ensure concentricity. Often one will spend more time making a fixture for machining a part than in making the part itself, particularly true when using a faceplate or milling.
- When the bits are all painted ready for final assembly, run a tap through the tapped holes to remove the paint.
- Stamp or etch mating parts as they are tried together to simplify life on final assembly.

These are a few of the faults I have found with Bill, but after five years working with him I think he has now become a very competent machinist and fitter. ■

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Readers' Tips

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TIP OF
THE MONTH
WINNER!



This month's winning tip is from Peter Farmer, who wins £30 of Chester gift vouchers for his tip for easily truing up a tired drill press.

Top Table Tip

I have just done a mod to my elderly pillar drill. As the table does not have slots it has always been difficult to clamp work to it. Also after trammig the table I discovered that the table slopes forward by about 0.010 inch which has caused me problems in the past. I have often wondered how I could overcome this and have at last come up with the answer.

With my Warco lathe came a faceplate which I have used only once in twenty years. I made a centre boss to locate the

centre of the faceplate to the only hole in the centre of the table. Then I drilled and tapped 6mm holes towards the outer edge of the faceplate in each of the slots and inserted brass grub screws so that I can adjust the height of the faceplate to cancel out the discrepancy.

This has been one of most useful and easiest mods that I have ever had to do in my workshop as I can now safely clamp my drilling vice to the drill table and I can still use the faceplate on the lathe if required.

This month's first runner up is Kenny Mackenzie, who obviously knows the white stuff. He wins an Edge Technology lathe tool setting gauge.

Make Mine Milk

I cut down the plastic milk containers to use as drawer liners to keep the drawers reasonably clean and also to be able to easily remove the liner to rummage through looking for item needed. Also the top/pourer can be used upside down as a disposable filter funnel to top up oil in family car etc.



No more than one prize with a value of £30 will be given each month. By entering you agree your entry can be freely published and republished MyTimeMedia on paper or electronically and may be edited before appearing. Unpublished tips may be carried forward to future months. You will be acknowledged as the author of the tip. There is no guarantee that any entry will be published and if no publishable tips are received a prize will not be awarded. The decision of the editor is final.

We have £30 in gift vouchers courtesy of engineering suppliers Chester Machine Tools for each month's 'Top Tip'.

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The second runner up is Robbie Van Staaldin in New Zealand, who wins a digital depth gauge.

Just the Ticket for Trammig

The problem I find when Trammig my mill after an angled setup is moving the Dial Gauge or DTI over the slots and trusting nothing has been disturbed. Well, I came across this large tapered roller bearing at work one day and it has never been simpler. This outer shell is from a 32022 bearing and has an O.D. of 170mm. They are precision ground and mass production has pushed the price right down. It can be purchased separately to the bearing and is known as a cup.

Lathe Headstock Extension

Part 2



Do you need a 500mm chuck? Cameron McKeown pushed his equipment to the limit, giving him the capacity to build a 6-inch traction engine.



It's something that all of us have been guilty of at one time or another – machine abuse! Many of us push our home workshop equipment to do the things they were never designed for, or ever thought capable of doing. How many times have we wished we had just that little bit more swing, saddle travel or extra length to a milling table? Over the years I have seen some amazing out of the box thinking in both the home and professional workshops to gain just that little bit more capacity to get the job done in house. This article describes the design concept and manufacture of a headstock extension to increase the swing of my lathe (**left**).

Taper roller bearings

You will notice I have employed taper roller bearings for the rolling elements. This design allows for final pre-loading of the bearings via a rear locking nut. The housings are filled with oil to around half where a drain plug is fitted. If you ever decide to make up a headstock extension don't be tempted to use deep groove ball bearings in this application thinking that it will make machining and fit up easier. They are not designed to handle excessive end thrust and cannot be pre-loaded which is essential to minimise vibration during machining. Machining for, and fitting up taper roller bearings in this application can be a fairly easy task in the home workshop if you take your time and creep up on the final diameters slowly. There is a lot of information on the internet showing configurations for tackling various loads and different machine applications. My approach to the design is, I want the arrangement to be easy to assemble, but more importantly I want to be able to disassemble easily without having to resort to the excessive use of hammers, dollies or welding to shrink the outer cup to remove it from the housing. In some bearing applications a blind bore is the only option and destruction of the bearing during removal is the only way. In this application an oversize counterbore at the back end of the bearing housing can be employed making it easier to

punch out and remove the outer cup if required. Bearing fitment and tolerancing is another aspect to the machining of both the housings and shaft. If you look at the tolerancing charts of a bearing catalogue the first thing you will notice is the extremely tight tolerance sets which in most cases requires precision machinery to accomplish. I have always taken these tolerance sets as a worst case scenario and in 90% of cases can be relaxed to meet the requirements of a general workshop provided this also suits the end application I have had many arguments over the years with bearing engineers and technicians over this philosophy. This 90% is certainly the case for most home workshop requirements. The cups are a light press fit into the housings, a warm up of the housings on the pot-belly stove or the outer cup into the freezer for a couple of hours is all that's needed for an easy drop in fit. The front end bearing cone is a light shrink fit onto the shaft, once again place the bearing ring on the pot-belly to expand and give a slide fit onto the shaft. A pre-check with a bore gauge and mic to ensure the clearances have opened up is always worthwhile before final fitment. The tail bearing is a light sliding fit onto the shaft with a spacer ring behind with the lock nut and lock washer taking up the rear. Machining a light 15 degree taper into the housings and shaft to start the bearings is good practice along with



Milling the rotary base register ring.

taper starts removing all sharp edges for the seals to slide over. The shaft design generally dictates that the largest diameter is the point of maximum shear and bending, in this case at the chuck end with the shaft size reducing to the tail or support bearing. With the bearings configured back to back this tapering arrangement allows for an easy fit-up. The whole headstock extension assembly was then pre-fitted, measured and clocked up to ensure it was parallel and square to the bed and that the lathe headstock and headstock extension spindles were in alignment (**photo 20**).

Seals

Seals are used to keep contaminants out while retaining the lubricant inside. As shaft rotation speed in this case is relatively low, standard lip seals are used. To minimise drag on the motor I have gone with oil filled housings rather than grease packed for the bearing lubrication. There is often some argument over which way lip seals should be fitted. If the rotating elements cavity is oil filled or pre-grease packed without a refill grease nipple I face the lip inwards so the metal back is facing outwards as in the application on the headstock extender. If the housing is to be re-greased via a grease nipple I have the lip of the seal facing outwards. This allows excess grease under pressure to open the lip and extrude out. I have seen on more than a few occasions where grease pumped into a housing builds up pressure and pops the seals out with quite a deal of force with the result everything within a couple of metres covered in thick grease. There are on the market some small proprietary pressure relief valves about the size of a standard grease nipple that are designed to relieve pressure in a housing at around 1 psi. If the seals required are a double lip type and need to be topped up with grease these should be employed. Seal selection in some applications is extremely important. I have experienced first-hand just what effect a replacement seal, different than the one originally specified can do to a shaft at high speed. The heat generated and resultant shaft surface damage in a very short period of time can lead to an expensive and embarrassing repair or replacement.

Gear ratio

As this arrangement will predominantly be machining larger diameters surface speed needs to be relatively low so I've aimed for a gear down ratio of around 2:1. My slowest lathe set speed is 45 rpm so a final chuck speed of around 22 rpm felt about right. Because I run all my machines through single phase inverters I have added a separate speed control pot to further fine tune the speeds. As I don't have forced cooling on the motors I am cautious about running at low motor rpm for any length of time due to the resultant heat build-up. Another benefit of running your lathe via an inverter is that the acceleration and deceleration times can be quickly programed in on the fly. This is especially beneficial with such a large diameter extension and the resultant inertia that needs to be overcome; a



The steel gears.



ramp up over a few seconds takes away the snap forces on the lathes geared head. If drive belts are used on your lathes transmission this will also give a dampening effect to the inertia.

Gears

Due to the large centre distance of 190mm between the lathe spindle centreline and the centreline of the headstock extension an idler gear was required. This gave a couple of advantages, firstly I could position the idler to meet the pcd's and gear meshing perfectly regardless of the gear centres, and secondly having an idler gear allows the spindle to run anti-clockwise in the forward position. The gears were cut using a horizontal milling attachment and arbour. The tooth module is 3 with the drive gear having 26 teeth the idler 34 teeth and the driven 55 teeth (**photo 21**). The teeth configurations were cut using 2 cutters in the brown and sharp style to match the number of teeth. These cutters can be purchased at very low prices from various suppliers over the internet. The quality of the cutters I purchased was very good, plenty of coolant at low revs and they are still as good as new. As these were spur gears I was concerned about 'ringing' (**photo 22**). On testing for the first time it became evident to me that it was going to rather annoying. The steel idler gear was replaced by a 'nylatron' idler gear (**photo 23**). Although some ringing was still evident it was certainly a lot better than with steel on steel. Using the nylatron material another problem was removed, that of lubrication between the gears. As my lathe is a short bed style I wanted to



A test run with the steel gear.

With the replacement Nylatron gear.

make sure that everything was kept up close to the headstock to ensure I had enough lathe bed to perform work up to 300mm in length. Clamping the drive gear into the 3 jaw chuck resulted in lost length. The solution was a purpose build adaptor that had the drive gear incorporated into it and that fitted directly onto the D1-4 nose of the lathe spindle. This was a two part assembly to aid the gear cutting with the gear spigot and locited into the D1-4 adaptor with a retaining cap for good measure. For the adaptor, a plug gauge was first made up from the scrap end of the stub axil used to make the shaft, this was blued to ensure the correct taper and fit into the nose. The other critical point about the D1 taper system is that when the adaptor is pulled up hard into the taper the front faces just need to kiss. The easiest way I found to do this is the machine the taper just slightly over size, then machine the face back continually checking with the plug gauge until both faces just kiss. I used the tail stock to provide light pressure to the plug gauge whilst doing this check. If you find you have missed the mark machine the taper out slightly again and repeat the process.

Chucks and face plates

To realize the true capacity of an increase in swing, larger chucks and a face plate needed to be sourced. The problem I found with this aspect of the project is that the bigger the equipment the more expensive it is. My ideal shopping list was for two four jaw chucks one at around 380mm in diameter and one at around 550mm in diameter and a face plate up to 600mm in diameter. After a

couple of months of looking on eBay and the online auction houses nothing suitable was showing up so with this in mind it was back to the cad to design up a faceplate that would incorporate a bolt on 4 jaw chuck system. Dxf files were generated from the cad drawings and again passed onto the laser cuter for profiling. The outer skirt was rolled and left open allowing me to fit up and position onto the face plate. I rough machined up the central registering ring and tack welded the gussets, outer skirt ring and central ring to the face plate leaving the final welding to my good friends at the technical collage. The face plate then needed to be stress relieved before machining, this was organized through a local fabrication shop at a time they had a load of other fabricated items that needed to be stress relieved. The final weldment after stress relieving is shown in **photo 24**. My plan was to machine the central registering ring using the boring head in the mill and directly mount onto the headstock extension with an adaptor plate to machine the whole thing *in situ* (v). Whilst following down this track I had earlier enquired to a number of local workshops as to whether they had any redundant four jaw chucks that I could purchase at a reasonable cost. A phone call from one of those workshops came through stating they had a 500mm diameter chuck that



The stress-relieved face plate.

was damaged and was I still interested. After work that night a visit was made, the chuck had a lot of rust on it as it had been sitting in water under some racking for many years. The good news was it was in one piece and was offered at no cost, the only down side was one of the jaws would continually lockup when being adjusted, hence the reason it had been discarded. After getting it home it was stripped down to find out what the problem was. It turned out one of the jaw adjustment screws was badly stripped. This was an easy fix, a build up with weld and a re-cut of the threads and it was like



Machining a register on the face plate.

new again, I couldn't believe my luck. What was going to be a face plate with mounted fabricated jaws could now be just a plain face plate. The chuck was a D1-8 mounting taper with a 4 position m16 bolt up from the rear face to mount to a D1-8 adaptor. A new adaptor was duly machined up to fit onto the spindle nose of the headstock extension and to



Machining the backing plate.



...and the backing ring.



The backplate fitted to the extension.



Truing up scrap laser cut plate.



The 500mm diameter chuck.



Finishing the faceplate register.



Truing the OD of the faceplate.



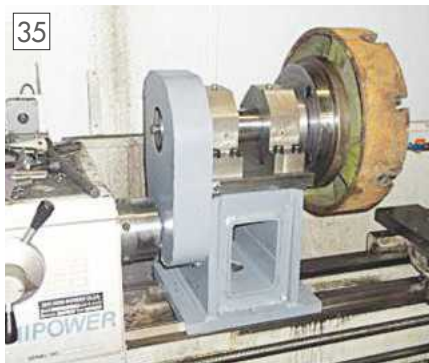
Facing the faceplate.

the chuck (**photos 26, 27 & 28**). I am fortunate to have a local metal supplier who has a range of scrap laser cut plates of various diameters and thicknesses for sale by weight. If you position the machining centre off centre in the drill press the laser cut in point can often be machined out leaving a good finish on the outer diameter (OD), **photo 29**. With the adaptor plate fitted the new chuck was mounted and checked for run out (**photo 30**). With the jaws of the chuck removed the tee slots could be utilized to secure the face plate for final machining of the central registering ring (**photo 31**) it was then turned around and mounted directly onto the D1-8 adaptor for rough machining of the face and outer edge this was the time to really see how this setup would handle machining at close to its maximum diameter and I must say it performed much better than I expected. I was able to take 3mm off the outer diameter in one cut with severe intermittent cutting at the outer weld joint whilst maintaining a good finish with no vibration (**photos 32 & 33**). After rough machining I let it sit for a few weeks prior to final machining (**photo 34**) to ensure all the creep was out of the structure. Once again the final finish on this setup was magnificent. The following week a 4 jaw Pratt and Burnerd chuck with an OD of 350mm came up for auction on the internet. I was the only bidder and picked it up for song. On getting it home to see what adaptors I would need to fit it up I

found to my luck it had a larger D1-8 adaptor already pre-fitted with the same 4 bolt holes through the rear face and at the same pitch as the larger chuck. It was a straight fit up with no adaption required (**photos 35 & 36**).

To be continued...

The completed faceplate.



The 350mm chuck attached to the extension.



A front view of the 'small' chuck.

Centring Work in the 4-Jaw



Gary wooding presents a step-by-step guide to a task that can frustrate the beginner.

There can be no doubt that it is easier and faster to centre something in the 3-jaw self-centring chuck, but the 4-jaw independent is generally more accurate and secure, as well as being more versatile. The trouble is, many people find using it to be both tedious and time consuming. Here is a method of using it that is easy, accurate and quick.



The simplest way of speeding up the process is to use two chuck keys, on opposing jaws. You don't actually need an extra key, but it's a great time saver. If you don't have a second key, then buy or make one. You won't believe the difference it makes.

The rest of this short article requires the use of a DTI (Dial Test Indicator). At first glance the procedure seems to be rather complicated, but it's really very simple, accurate and quick.

Step 1

Put the bar in the chuck and centre it by eye as best you can.

Set the DTI up on centre height to point at the true centre of the lathe, and then rotate the chuck to get the lowest reading on the DTI, as shown in **fig. 1**. Don't worry about the positions of the chuck

jaws at this stage; you are only interested in getting the lowest reading on the DTI. At this point, set the DTI to zero.

In the diagram, the dotted circle represents where the bar will be when it has been centred. The light coloured jaw shows how the chuck has been rotated.

Step 2

Rotate the chuck to get the maximum reading on the DTI. In **fig. 2** this is shown as 2.7, but that is just an example to illustrate the process. Divide that value by 2 (to get 1.35 in this example), and remember that value.

Step 3

Continue to rotate the chuck until the DTI shows the remembered value – 1.35 in the example shown in **fig. 3**. Then set the DTI to zero.

Step 4

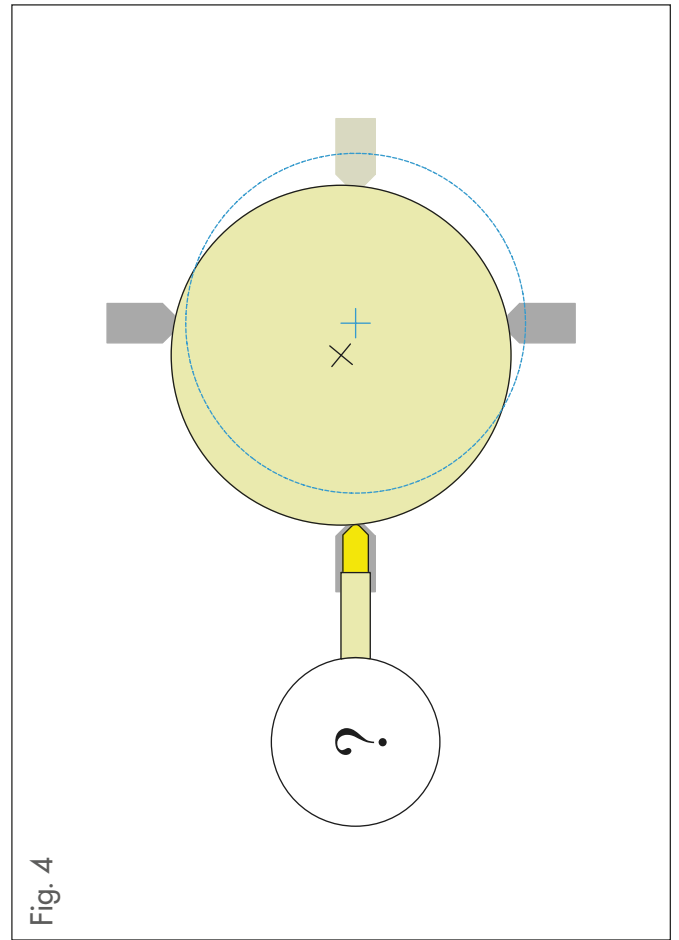
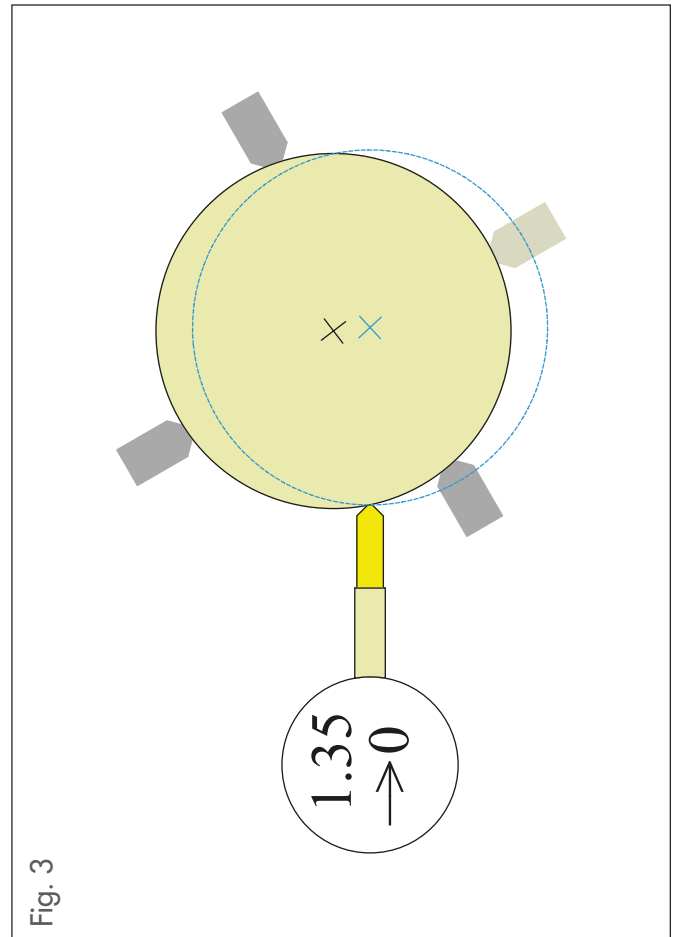
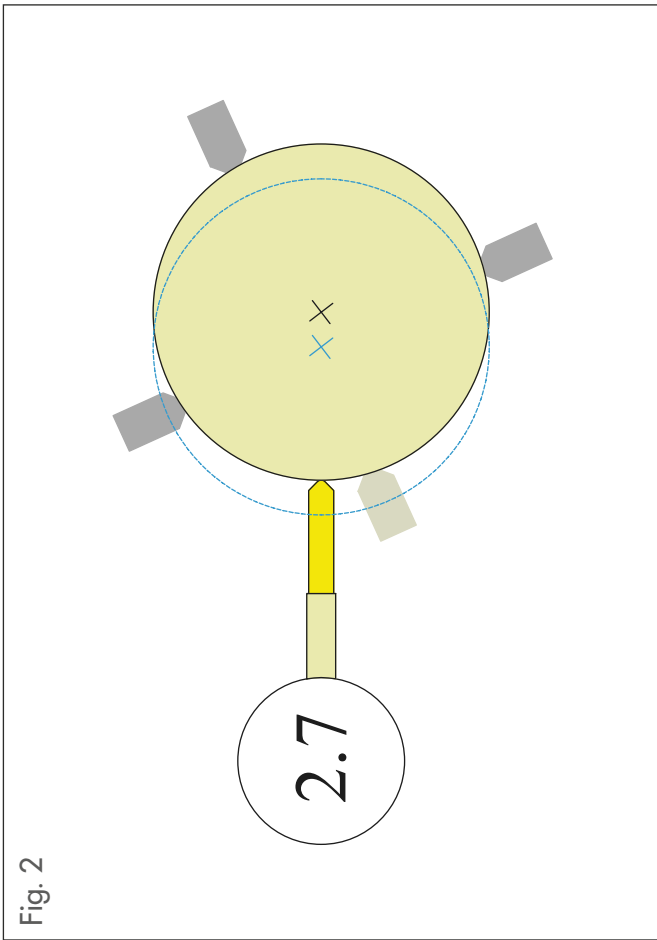
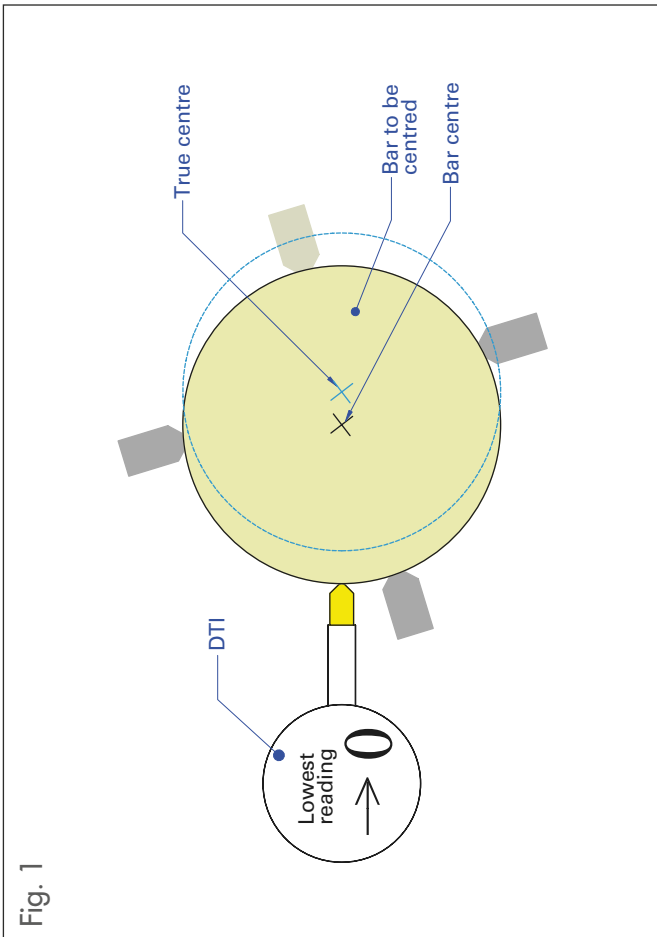
Continue to rotate the chuck until the next jaw is aligned with the DTI (**fig. 4**). Now adjust the two horizontal jaws to zero the DTI as shown in **fig. 5**.

Step 5

Continue to rotate the chuck to align the next two jaws to the DTI (**fig. 6**), and adjust them to zero the DTI, as shown in **fig. 7**.

At this point the bar is just about centred, which can be confirmed by one more revolution of the chuck.

It's far quicker to do it than to read how to do it. Give it a try, you'll be surprised. If you think about it, setting the DTI to zero as in **fig. 3** sets it to the true centred position of the bar. ■



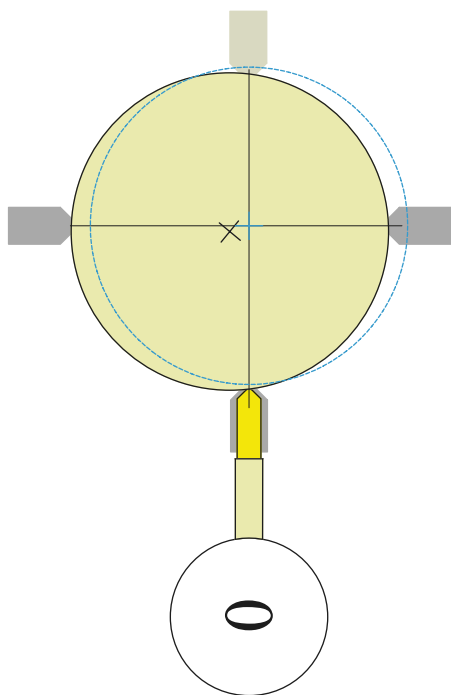


Fig. 5

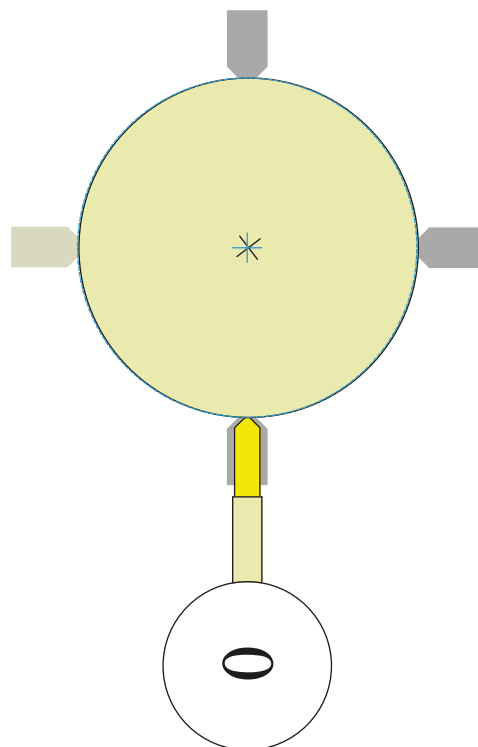


Fig. 7

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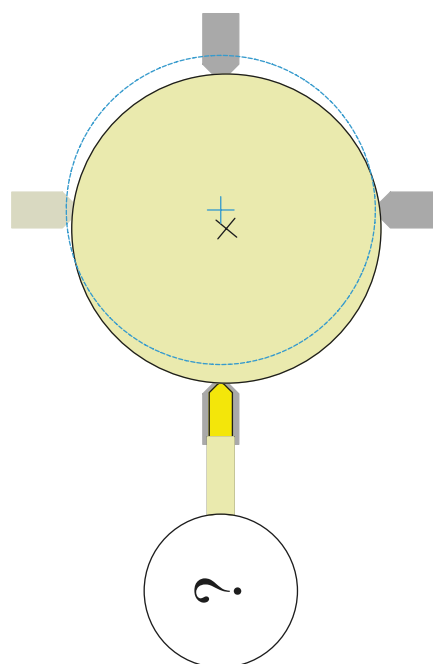


Fig. 6

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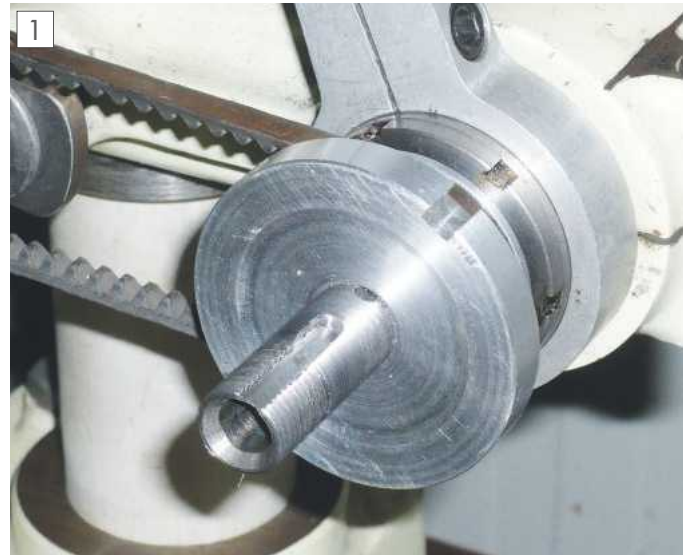
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A Quorn and a Crane

Harry Cosh, in Victoria, Australia, tells a tale that may help those who struggle to move heavy equipment.



Last year I suffered an injury to my right elbow and am no longer able to lift heavy weights. The first problem in the workshop was changing chucks on my lathe so I started to design a crane. I intended one just to lift the lathe chucks but after some thought I decided I should cover the whole workshop because at 87 I do not expect my elbow to improve so I built an overhead crane based on the 'C' section beams I had used to install a mezzanine floor above my workshop. I have taken some photos of the crane and for those interested I will detail them later in the article.



Longer shaft and nut.

The Quorn

The reason for the above introduction is it is what led me to modifying my 'Quorn' tool and cutter grinder. I had also discovered I could no longer lift the grinding head off my fully fabricated version of the Quorn, (detailed in *MEW* Issues 79 & 80) to turn it over so I thought 'another task for the crane' but found I needed to design a jig to lift and rotate the head 180 degrees in the vertical plane before lowering it back on to the column, then I thought why do you need to lift and turn it over. By having a wheel each end of the spindle you would not need to. I then designed a longer spindle, the pulley is keyed and the grinding wheel inner backing plate is threaded to act as the nut (**photo 1**). The outer grinding wheel clamp plate is keyed (**photo 2**). **Photograph 3** shows both plates. A lugged washer is used as an extra safety precaution to prevent the wheel clamp nut undoing. (**photo 4**). **Photograph 5**



Outer keyed clamp plate.



Grinding wheel clamp plates.



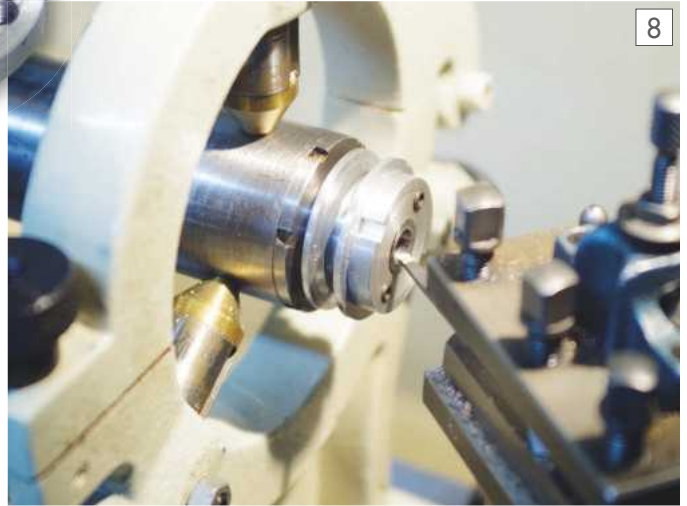
Lugged washer.



Showing double wheels.



One wheel only. inset: New nut.



Facing shaft to nut.

shows the double wheels, the right hand wheel can be removed (**photo 6**) when using the left.

This worked ok but changing the left hand wheel and redressing it was time consuming so after some time I decided to try and use the existing interchangeable ones. I then refitted the original shaft, made a new nut with grub screw to lock it as shown in **photo 7**. I then faced the shaft back to the nut (**photo 8**) then drilled and reamed the bore (**photo 9**), then machined the 40 degree included taper (**photo 10**). This left a witness mark at the outer end of the thread but if you machine deeper and continue the taper out into the nut a little it will bridge the end of the thread. This may mean using larger diameter wheel arbors than the 1/2 inch diameter as per the Quorn drawings. The purpose of the grub screws is to lock the nut in place so that once machined it will not move and be part of the taper. **Photograph 11** shows the work head which is now able to use interchangeable wheels at either end, being swung into position instead of having to be removed from the column and inverted. On the standard Quorn the belt guard could be modified by cutting it back towards the capacitor housing and fabricating a sheet metal guard for the belt and wheel, also the draw bar washer should be modified to suit the 40 degree taper.

The nut I made is 32 x 6mm the grub screws are 5mm x .8mm pitch on 22mm PCD. I used two for balance. Any other suitable dimensions can be used. The material I used is aluminium but I think mild steel would better.



Reaming the bore.



Machining the 40 degree included taper.

The purpose of the grub screws is to lock the nut in place so that once machined it will not move and be part of the taper.



Work head being swung.

Crane

A general view of the crane that started the Quorn modification is shown in **photo 12**. It can cover most of the

workshop. Another view showing more detail is **photo 13**. The trolley is shown positioned in the C-sections with the end



General photo of crane.



More details of crane.

stop removed in **photo 14**. Trolley details are in **photo 15**. **Photograph 16** shows the hoist picking up a 3-jaw chuck with its jaws clamped on the lifting jig which has a rotating section marked at the balance point for each chuck, this allows the chucks to be rotated for easy alignment. **Photograph 17** shows the 3-jaw chuck removed and **photo 18** shows it placed on the bench. **Photograph 19** shows picking up the 4-jaw chuck which has been rolled out of the cupboard on to a temporary stand to save lifting. **Photograph 20** shows the 4-jaw chuck being installed.

I can now change chucks on my lathe, use my Quorn and move heavy items in my workshop without aggravating my injury, so the effort was worthwhile. I hope the above information may be useful to others. ■



Trolley in C section.



Trolley.



Picking up 3 jaw chuck.



Removing 3 jaw chuck.



3 Jaw chuck on bench.



Picking up 4 jaw chuck.



4 Jaw chuck installed.

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Simple Speed Control of DC Motors

Part 2



Many applications where a low power direct current motor is required often calls for a method of adjusting the speed. A typical application in the home workshop might be to drive a leadscrew on a milling machine table whilst surfacing a long work piece. The motor replaces the tedious turning of the handle and if the speed can be set slow enough the end product is not only better but with a lot less effort. By making the motor to run at high speed the table can be brought to the required position in little time. The larger industrial milling machines have table drive motors as normal fittings but the budget type of milling machine for the home workshop mostly do not have this luxury. Although one can buy add on drive mechanisms they tend to be expensive and not always applicable to all of the small milling machines.

Whereas many model engineers can come up with a suitable mechanical adaptation to fit a small motor and gearbox to drive the leadscrew the subject of speed control is often one they are unfamiliar with. So this article offers some alternative methods, some very basic and easy to implement and ending with a useful accessory that can be made for little outlay in effort or money.

One of the most common requests on the ME forums is for a simple, reliable controller for 12V DC motors. *Inchanga* spent a large part of his career working on motor drives for a military contractor and, in retirement, spends much time on motor drives for radio telescopes including the Square Kilometre Array being built in the Karoo Desert. He offers us a tested design planned for construction by relatively inexperienced hobbyists.

Switches

Toggle switch SW1 is a high current single pole single throw (make) type (SPST or 1PST), although SPCO / SPDT types can also be used leaving the unused pin unconnected. SW2 is a high current two-pole change over type (DPDT or 2PCO) and will have sets of 3-pins or tags in two rows. The two centre ones are the common and the other pins or tags need to be cross-wired to get the reversing action. (See the sketch of a typical type. NO and NC stand for *normally open* and *normally closed*). Use insulated wire to make the diagonal cross connections between the tags. For this current rating type of toggle switch they normally require a 1/2 inch mounting hole in the panel and are attached with the nut and washer supplied.

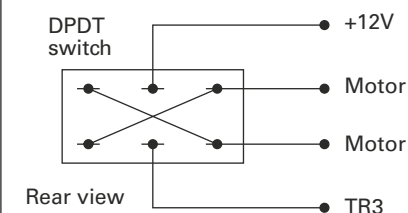
Printed Circuit Board

The track side of the board is shown in **figure 7**. This is what you see looking at the bottom of the board after it is etched. (The dark areas are unetched copper and the white areas are where the copper has been etched away). The lettering should be right-reading and not reversed, this serves as a check you have the artwork the correct way around. The round 'doughnuts' are pads for either component leads, terminal points for external wiring and the four corner pads are for the mounting pillars and screws. These need to be drilled with a suitable size drill. **Figure 8** is a view of the component side of the board showing the component locations and values.

The board can be etched using ferric chloride once the photo-resist has been exposed to ultra-violet light with the artwork positive. It is important to ensure the artwork is exactly the correct size. The board dimensions are shown on Figure 7 and if a photocopier is used to scale the board correctly all the components will fit perfectly.

The dimensions are shown in inches, as even today most printed circuit board layout programs still work in imperial

Fig. 6



dimensions, as most common component are based on multiples and sub-multiples of 0.1 inch. If you must use metric then the board size is exactly 60.96mm x 50.8mm, isn't 2.4-inch x 2.0-inch so much easier? If you have a steel ruler graduated in tenths of an inch you are in clover. As a check - the pad spacings of the IC are exactly 0.1 inch (2.54mm) between pins and 0.3 inch (7.62mm) across the width.

A simple method to get a positive artwork is to firstly scale the layout onto normal photocopier paper by trial and error and once you have the correct scale factor you then insert a sheet of clear Mylar film into the paper tray. This film is obtainable for overhead projectors in A4 size and a laser copier with black toner will provide a perfect image on this film. This film is then laid onto a photo-sensitive positive resist pre-coated board, (available from several suppliers, RS Components for example sell small boards already coated) ensuring it is the right way up so the lettering reads correctly. Tape the film master to the board so it cannot move. Expose it to ultra-violet light, normal sunlight works fine it just takes a little longer. When the board has been exposed the unwanted photo resist is washed away with a dilute solution of caustic soda and the board rinsed in clean water and dried. Now is the time to touch up any areas that might be suspect, a felt tip fine pen will

cover any minor blemishes. When the board has been dried – a hairdryer is a useful method – it is immersed in ferric chloride etching solution and the unwanted copper is etched away. Wash and rinse the board after etching and gently abrade off the photo-resist with a little steel wool and then dry before drilling the holes for component leads etc. The remaining copper should be bright and shiny, keep your greasy fingers off the copper as it makes the soldering more likely to cause dry-joints. So give the drilled board a wash and brush up with some dishwashing liquid and warm water before a final rinse and drying.

Note: There is one wire jumper link required on the board fitted between C3 and IC1; this can be an offcut of one of the resistor leads. Bend this and insert in the two holes and solder like a normal component. Terminal pins can be used for the termination wires or the wires can be soldered directly into the pads. The wires for the motor and ground need to be sufficient diameter to carry the full motor current; the other wires can be a lighter gauge as the current in these is low. Use insulated hook up wire for these connections. The pot can be mounted anywhere convenient with any length of wire necessary to attach to the board.

Figure 9 shows the details for the heat sink bracket for TR3. The bracket extends over the end of the board for bolting to the main enclosure for additional heat sinking should it be required. The top hole locates on the corner fixing screw for the board. The dimensions are imperial taken directly from the board layout and can be converted to metric if you desire. For example the 0.315 inch dimension is exactly 8mm and the 0.585 inch dimension is 14.8mm, 15mm would be acceptable. The heat sink can either be bent up from aluminium sheet or a slice off a $\frac{3}{4} \times \frac{1}{8}$ inch aluminium angle would also suffice. The box mounting screws on the vertical portion can be spaced around 20mm apart for M3 or 6BA screws tapped into the bracket or clearance holes as you wish.

The amount of heat sinking required is determined by the average current the motor draws. The power dissipated in TR3 is the product of the square of the average current flowing in the on-resistance of $70\text{m}\Omega$. For an average current of 10A it will dissipate $(10 \times 10 \times 0.07) = 7\text{W}$. As the average current falls the dissipation becomes less, for an average current of 1A the power dissipated is only 70mW. If the lower on-resistance IRFZ-44N were used these figures are lowered to 2.2W at 10A and only 22mW at 1A and the heat sink can be reduced in size. The maximum safe power dissipation of the IRFZ-24N from the data sheet is 45W when clamped to a heat-sink with a device temperature of $+25^\circ\text{C}$ and the IRFZ-44N is 110W. For heat-sinks less than this the device temperature will rise above $+25^\circ\text{C}$ and the allowable dissipation possible falls pro rata. (If when running at maximum speed the heat-sink is too hot to touch it isn't large enough). The average current drawn by a windscreen wiper motor for a family saloon is about 1 to 1.5A with no load and about 5A at maximum load when operated on 13.8V. Under these conditions the maximum power dissipated in the IRFZ-24 would be 1.75W.

Fig. 7

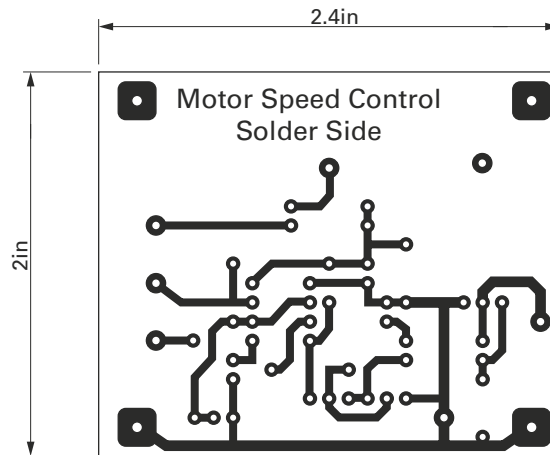
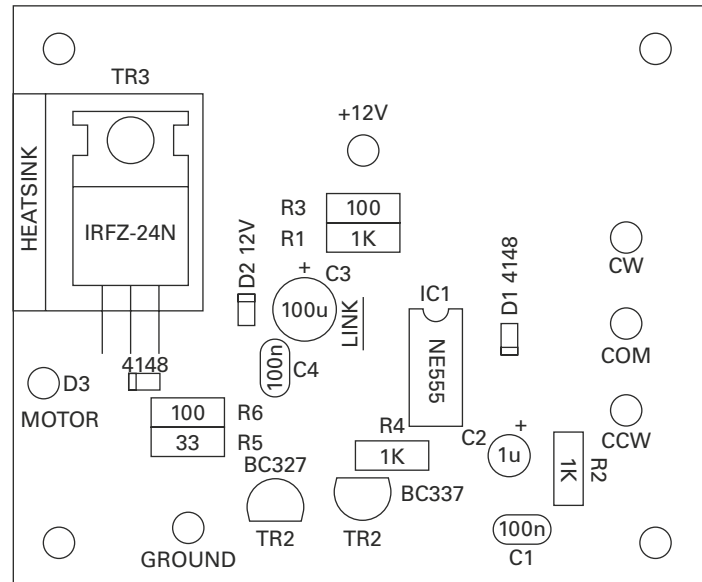


Fig. 8

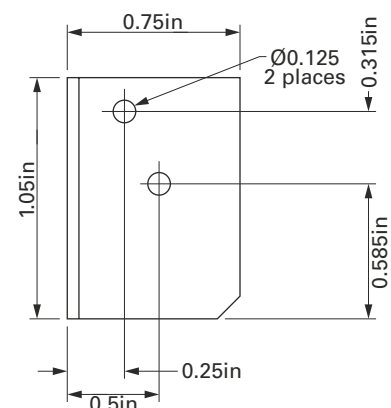


Testing

As most constructors will not have much in the way of electronic test equipment I have assumed you only have a simple multi-meter. Although today the digital voltmeter (DVM) is low cost and easy to use the older voltmeters with a needle pointer are a better option. The meter needle is heavily damped and therefore averages the reading better. Start by connecting the board to a 12V dc supply, preferably a low current type at first. Connect a 12V / 6W lamp in series from the positive terminal of the supply to the point on the board marked MOTOR. This lamp will serve as an indicator of the average current drawn when switching. This circuit is a really good lamp dimmer for 12 or 24V bulbs!

Place the positive probe of the voltmeter onto either end of R3 with the negative

Fig. 9



connected to ground. (Take care that the probe does not short to an adjacent pin). Vary the control VR1 from one end to the other and the voltage should rise from close to zero volts up to 12V. The lamp should vary in brightness as VR1 is varied. If you have an oscilloscope then the pulse width will be seen to vary from virtually zero to almost continuous as the pot is varied.

If the board passes all these tests you are ready to complete the final wiring and connect up the motor for a first trial run. If the motor runs in the wrong direction for your application, simply swap the wires to the motor to the opposite polarity or loosen SW2 and rotate it through 180° on the front panel.

One word of caution regarding the reversing switch SW2. **Do not switch this with the motor running near maximum speed.** This causes a large current spike to flow as the motor is reversed. Rather select the slowest speed or switch the motor off first with SW1 to prevent undue stress to the Mosfet transistor and motor.

Component Substitutions and Equivalents

The resistors can be either carbon film or metal film 1/4W types. These are available in various tolerances from 10% down to as low as 1%, the closer the tolerance the more they cost. For non-critical applications such as this it doesn't warrant the more expensive types and a 10% carbon film resistor is the lowest cost. The most expensive device in this design is the Mosfet.

The variable resistor VR1 is known as a potentiometer or 'pot' for short. These are available in a variety of sizes, mounting methods, terminal style, shaft diameter and track law. We need a 100 kΩ pot with a linear law, which is different to a volume control pot that has a logarithmic law. (Log pots are often marked in the style '100k-A' and linear pots use the B suffix).

You will also need a suitable knob to fit the pot shaft. Many panel mount pots require a circular hole about 8 to 10mm diameter and it is retained with the supplied nut and washer. Pot shaft diameter also vary, 6mm and ¼ inch being common although other diameters exist, ensure the knob is suitable.

The choice of the devices for TR1 to TR3 is quite wide and many other devices will work satisfactorily in the circuit. The devices shown I carry in my normal stock inventory but they may not be available from all component suppliers. (For mail order RS

MOTOR SPEED CONTROL BOARD			
Component Bill of Materials & Layout Details			
Bill of Materials			
Qty	Type	Value	Ref Designators
3	1/4W MF 10%	1kΩ	R1, R2, R4
1	1/4W MF 10%	33Ω	R5
1	1/4W MF 10%	100Ω	R3
1	Zener diode 1/2W	12V	D2
2	Switching Diodes	1N4148/1N914	D1, D3
2	Ceramic (2.54mm)	100n/50V	C1, C4
1	Tantalum	1u/35V	C2
1	Electrolytic (2.54mm)	100u/25V	C3
1	Timer IC (DIL 8)	NE/LM-555	IC1
1	NPN (TO-92)	BC337-25	TR1
1	PNP (TO-92)	BC327-25	TR2
1	Mosfet N (TO220)	IRFZ-24N	TR3
Additional Components			
1	Toggle Switch SPST		10A type
1	Toggle Switch DPDT		10A type
1	100k linear pot		VR1
4	Spacer Pillars		3mm Hole x ≈6mm long
1	Fuse Holder + Fuse		6A Fast Blow Fuse
1	TO220 Insulator Washer + Insulator Bush		
1	TO-220 Heatsink + M3/6BA Hardware to suit		
A/R	Insulated Hook-Up Wire		

Components and Farnell are two suppliers that offer a wide range of types, usual disclaimer applies, and can be ordered on the internet with credit card payment).

TR1 is a low power NPN transistor in a TO-92 plastic package (see Fig-10) with a minimum gain of 250, the 25 after the part number designates the gain selection. The BC337 is available in 160, 250 and 400 gain selection and hence its full part number can be BC337-16, BC337-25 or BC337-40, the higher the gain the more expensive the device costs. Some manufacturers use letters instead of numbers to indicate the gain version, A normally being the lowest, so a BC337B is the same as a BC337-25 in most cases. Suitable substitutes are the BC338-25, BC107B, BC108B, 2N2222B etc. Similarly TR2 is a PNP version of the same generic transistor type and again is available in three gain selection ranges, 16, 25 and 40 as per the BC337. Alternatives are the BC328-25 and 2N2907B. Other alternatives may require the leads to be re-orientated to fit the board correctly, check with the device data sheet for the correct pin-out, there are several variations of which of the pins does what in the TO-92 package! All Mosfet in the TO-220 package I have come across have a standard pin configuration so they will fit without any changes to the lead arrangement. The important parameters are the maximum voltage, current and on-resistance; there are many types that will satisfy the requirements. **Figure 11** shows the TO-220 package for common Mosfet types.

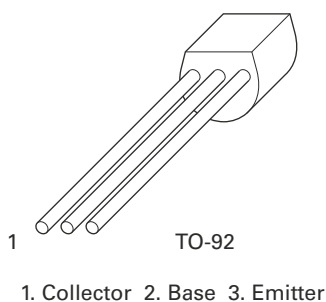
The header photograph shows the board under test. The Mosfet has a right angle

heat sink bracket with an additional piece of heat sink bolted to it for extra heat dissipation. Normally the metal enclosure would have sufficient heat sinking. The variable pot is connected directly to terminal pins for easier testing. The machine vice is a convenient way to hold the board and prevents it from moving, as it is a heavy piece of cast iron. The motor used as a load is a window winder motor that draws 6A at fully load. During testing the frequency of the pulses were varied by substituting different values for C1. The results were interesting and confirmed the need for a lower rather than a high switching frequency.

Test results

With C1 being 100n the frequency was about 150 Hz, with a 10n capacitor the frequency was 1.5 kHz and with a 1n capacitor the frequency was about 16 kHz. However, operating on the higher frequencies gave a reduction in maximum speed and poorer starting at low duty cycles. Upon investigation the current in the Mosfet at low duty cycles was found to be higher than expected. This is due to the Back EMF being low at low rpm. Without the Back EMF the limitation of the current is simply due to the resistance of the armature windings. As the speed increases the Back EMF rises to oppose the applied voltage and the peak current falls. So at very low duty cycles the peak current is high and this allows higher torque to be generated at low speeds. As the speed increases the Back EMF rises and the peak

Fig. 10

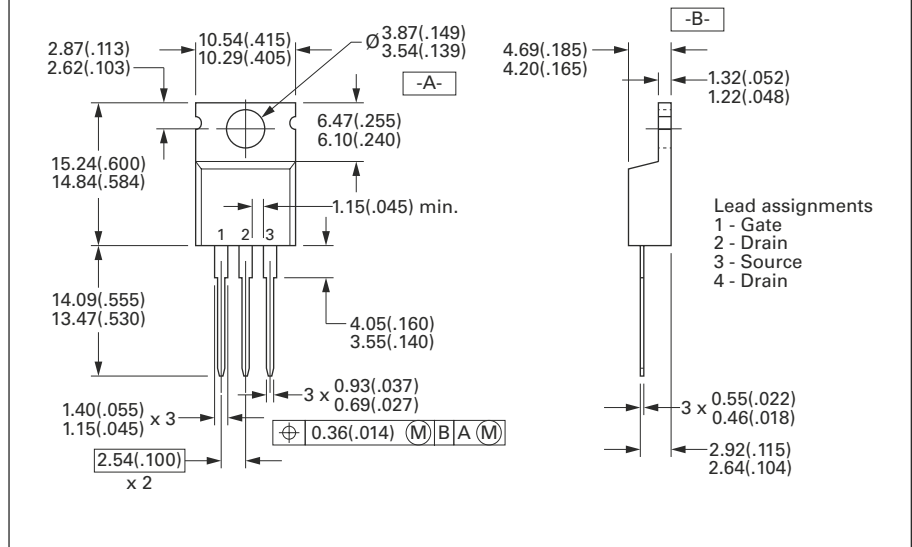


and average current falls. The result of this is that the torque remains reasonably constant over the speed range.

However, applying a square wave drive to an inductive load, which the armature windings present, causes the current to ramp upwards slower than if feeding a pure resistive load such as a lamp. The shape of the current waveform becomes more like a triangle than a square wave. Using a high switching frequency does not allow the peak current to rise as high during the switch on-time and the torque is lower, noted by the need to increase the duty cycle to start the motor rotating. This effect is also the reason the maximum speed is lower; the current is not on for a long enough time to accelerate the armature up to its correct speed. The problem with using a low switching frequency is the audible noise that the motor makes at low speed, it is a buzzing sound at slow speeds but this dies away as the speed is increased. At 1.5 kHz switching frequency the noise made was very noticeable at low speeds and could be irritating. At 15 kHz there was still some noise audible at low speeds, not so much from the switching rate but from the armature *cogging effect*, and the low speed performance was poor. It required almost 40% duty cycle just to get the motor turning. Several different dc motors were tried, from toy motors to larger ones and they all exhibited similar effect with a change in switching frequency. This effect is not mentioned in any of the literature the writer has become across on PWM of dc permanent magnet motors, although it is covered in the 3-phase variable speed drives in common use.

The use of high switching rates also brings about a problem with the inductive nature of the windings. These also generate

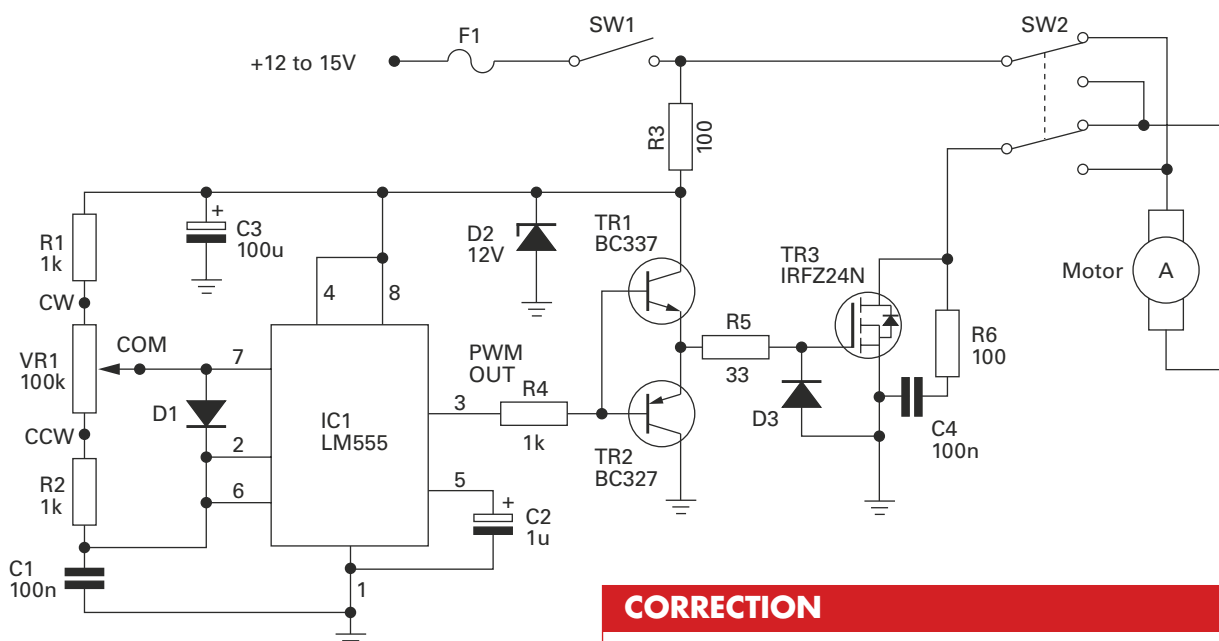
Fig. 11



a large spike at switch off and if the switching frequency is too high the induced voltage can be sufficient to cause permanent damage to the switching transistors, so great care also needs to be taken to limit the maximum frequency. Another major concern is the low speed operation of ac induction motors, which is a subject in itself that the writer intends addressing in another article later. The basic problem is the cooling effect and the circulating currents in the armature conductors. In ac induction motors that have an internal fan cooling the armature drives the cooling impeller which draws air through the motor casing. If the speed is set below about 30% of the maximum

rated speed the cooling airflow drops too low to effectively cool the motor. If the load on the motor is high this limits the safe operating temperature. Many manufacturers of ac induction motors strongly recommend that the motor should not be operated at full load torque below 1/3 of its rated speed for this reason. For external forced air cooling with a separate blower motor the problem does not exist, but this type of motor is normally the larger industrial types, not normally found in home workshops. The ac induction motor is an interesting item to analyse and predict the operation due to the way it generates the magnetic fields, both within the stator and the armature. ■

Fig. 4



CORRECTION

Unlike the Editor, many readers have spotted an error in Fig. 4 in the last installment, as TR2 was drawn as an NPN transistor instead of a PNP one. The version here has been corrected. Apologies to all, including Inchange whose original drawing was correct.



Model traction engines getting up steam in front of the exhibition hall.

Harrogate Show 2015



Editor, Neil Wyatt enjoyed a visit to the National Model Engineering Show in May.



Inside the hall it was nice and busy.

I got to the show on Saturday morning a little later than last year, and it seemed that visitor numbers were good, as I had to park at the bottom of the hill and walk up the show building! Outside a large number of traction engine, apparently mostly in 2 and 3 inch scales were getting up steam (**photo 1**). Surely even the stoniest heart is moved to joy by the smell of coal and hot oil on a grey morning?

Once inside the building, the healthy level of visitors was confirmed (**photo 2**), although Gavin Rex assured me that the day before was even busier!



John Stevenson demonstrated the EMG-12...



...to an appreciative audience.



Chester were doing a brisk trade in these more modest tool sharpeners.



The Acute Tool Sharpening System...



...demonstrated by Gary of Eccentric Engineering.



Mark Noel's Multigrind.

In the run up to the show it had been widely publicised that John Stevenson would be demonstrating Arc Euro Trade's EMG-12 end mill sharpener featured in last month's issue (**photo 3**). John (a.k.a *The Ilkeston Raider*) had a constant flow of visitors bearing handfuls of endmills from the lightly worn to brutally abused (**photo 4**). Despite the relatively high cost of the machine, it has proven popular and we here Arc are importing a second batch to meet demand.

Interestingly, tool grinding seemed to be the dominant theme of tools at the exhibition with a wide range of approached on display. At just £40, this little grinder from Chester (**photo 5**) was very tempting, with a nice wide wheel and decent integrated tool rests, and now I regret not grabbing one just for lathe tooling. You can't have too many grinders, can you? Chester also had a good selection of their hobby-size mills and lathes on display.

Another, very different approach to tool grinding was the utterly ingenious *Acute Tool Sharpening Sytem* from Eccentric Engineering (**photo 6**). Gary Sneesby had travelled all the way from Australia to demonstrate the system to an enquiring audience (**photo 7**). The system uses a collection of well thought out jigs, to facilitate rapid and accurate sharpening of

all sorts of tooling. It is available as both a fully finished system or as a laser-cut kit, and we will take a closer look at it in a future issue. Gary also brought along Eccentric's mascot *Cuborg* who is gracing this month's cover.

One grinder on display was as cheap as they get - at least before you add on the diamond wheels. Mark Noel's *Multigrind* won a Highly Commended certificate (**photo 8**), though it bears a suspicious resemblance to a recycled Kenwood Chef. It was displayed next to Maurice Fagg's delicate coil winding machine (**photo 9**) on the SMEE stand. I think each gentleman

was rather bemused by the other's work (**photo 10**)! A useful bit of kit, not a novelty, we shall hear more of the *Multigrind* anon.

To be continued...



Maurice Fagg's coil winder.



Mark and Maurice resplendent in their SMEE livery.



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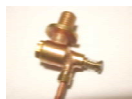
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	-	-	M 14.00 x 2.00	0.5518	12.10 mm	$1\frac{5}{32}$	$\frac{1}{2}$	12.70 mm
			M 14.00 x 1.50	0.5518	12.50 mm	$\frac{1}{2}$	$\frac{33}{64}$	13.00 mm
			M 14.00 x 1.25	0.5518	12.80 mm	$\frac{1}{2}$	$\frac{33}{64}$	13.20 mm
-	$\frac{9}{16}$ - 12	-		0.5625	$\frac{31}{64}$	0.4844	$\frac{33}{64}$	0.5156
-	$\frac{9}{16}$ - 18			0.5625	$\frac{33}{64}$	0.5156	$\frac{17}{32}$	0.5312
-	$\frac{9}{16}$ - 24			0.5625	$\frac{33}{64}$	0.5156	$\frac{17}{32}$	0.5312
-	-		M 15.00 x 1.50	0.5902	13.50 mm	$\frac{17}{32}$	$\frac{35}{64}$	14.00 mm
-	$\frac{5}{8}$ - 11	-		0.6250	$\frac{17}{32}$	0.5312	$\frac{9}{16}$	0.5625
-	$\frac{5}{8}$ - 18	-		0.6250	$\frac{37}{64}$	0.5781	$\frac{19}{32}$	0.5938
-	$\frac{5}{8}$ - 24	-		0.6250	$\frac{37}{64}$	0.5781	$\frac{19}{32}$	0.5938
-	-		M 16.00 x 2.00	0.6295	14.00 mm	$\frac{35}{64}$	$\frac{37}{64}$	14.75 mm
			M 16.00 x 1.50	0.6295	15.00 mm	$\frac{37}{64}$	$\frac{19}{32}$	15.00 mm
-	-		M 17.00 x 1.50	0.6689	15.50 mm	$\frac{39}{64}$	$\frac{5}{8}$	16.00 mm
-	$1\frac{1}{16}$ - 24	-		0.6875	$\frac{41}{64}$	0.6406	$\frac{21}{32}$	0.6562
-	-		M 18.00 x 2.50	0.7083	15.50 mm	$\frac{39}{64}$	$\frac{41}{64}$	16.50 mm
-	-		M 18.00 x 2.00	0.7083	16.00 mm	$\frac{5}{8}$	$\frac{21}{32}$	16.75 mm
-	-		M 18.00 x 1.50	0.7083	16.50 mm	$\frac{21}{32}$	$\frac{43}{64}$	17.00 mm
-	-		M 19.00 x 2.50	0.7476	16.50 mm	$\frac{21}{32}$	$1\frac{1}{16}$	17.50 mm
-	$\frac{3}{4}$ x 10	-		0.7500	$\frac{21}{32}$	0.6562	$1\frac{1}{16}$	0.6875
-	$\frac{3}{4}$ x 16	-		0.7500	$1\frac{1}{16}$	0.6875	$\frac{45}{64}$	0.7031
-	$\frac{3}{4}$ x 20	-		0.7500	$\frac{45}{64}$	0.7031	$\frac{23}{32}$	0.7188
-	-		M 20.00 x 2.50	0.7870	17.50 mm	$1\frac{1}{16}$	$\frac{23}{32}$	18.50 mm
-	-		M 20.00 x 2.00	0.7870	18.00 mm	$\frac{45}{64}$	$\frac{47}{64}$	18.50 mm
-	-		M 20.00 x 1.50	0.7870	18.50	$\frac{47}{64}$	$\frac{3}{4}$	19.00 mm
-	$1\frac{3}{16}$ - 20	-		0.8125	$\frac{49}{64}$	0.7656	$\frac{25}{32}$	0.7812
-	$\frac{7}{8}$ - 9	-		0.8750	$\frac{49}{64}$	0.7656	$\frac{51}{64}$	0.7969
-	$\frac{7}{8}$ - 14	-		0.8750	$\frac{13}{16}$	0.8125	$\frac{53}{64}$	0.8281
-	$\frac{7}{8}$ - 20	-		0.8750	$\frac{53}{64}$	0.8281	$\frac{27}{32}$	0.8438
-	$1\frac{5}{16}$ - 20	-		0.9375	$\frac{57}{64}$	0.8906	$\frac{29}{32}$	0.9062
-	1.00 - 8	-		1.0000	$\frac{7}{8}$	0.8750	$\frac{59}{64}$	0.9219
	1.00 - 12	-		1.0000	$1\frac{5}{16}$	0.9375	$\frac{61}{64}$	0.9531
	1.00 - 20	-		1.0000	$\frac{61}{64}$	0.9531	$\frac{31}{32}$	0.9688

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16 BA	-	0.08 mm	0.0311	0.60 mm	0.0236	-	-	
15 BA	-	0.09 mm	0.0354	0.70 mm	0.0276	-	-	
14 BA	-	M 1.00 mm	0.0394	0.80 mm	0.0315	-	-	
13 BA	-	M 1.20 mm	0.0472	0.98 mm	0.0386	-	-	
12 BA	-	M 1.30 mm	0.0512	1.05 mm	0.0413	-	-	
11 BA	-	1.50 mm	0.0591	1.20 mm	0.0472	-	-	
-	0-80	-	0.0600	$\frac{3}{64}$	0.0469	-	-	
$\frac{1}{16}$ - 60	-	-	0.0625	$\frac{3}{64}$	0.0469	-	-	
10 BA	-	1.70 mm	0.0669	# 54	0.0550	-	-	
-	1-64	-	0.0730	# 53	0.0595	$\frac{1}{16}$	0.0625	
-	1-72	-	0.0730	# 53	0.0595	# 52	0.0635	
-	-	M 1.50 x 0.35	1.49 mm	1.15 mm	0.0465	# 56	# 55	
-	-	M 1.60 x 0.35	1.59 mm	1.25 mm	0.0520	# 55	# 54	
-	2-56	-	0.0860	# 50	0.0700	# 49	0.0730	
-	2-64	-	0.0860	# 50	0.0700	# 48	0.0760	
-	-	M 1.80 x 0.35	1.79 mm	1.45 mm	0.0595	# 53	$\frac{1}{16}$	
9 BA	-	1.90 mm	0.0748	# 53	0.0595	-	-	
-	-	M 2.00 x 0.40	1.99 mm	1.55 mm	$\frac{1}{16}$	# 51	1.70 mm-	
-	-	M 2.00 x 0.45	1.99 mm	1.60 mm	0.0635	# 50	1.75 mm	
-	-	M 2.20 x 0.45	2.19 mm	1.75 mm	0.0700	# 48	1.90 mm	
8 BA	-	2.20 mm	0.0865	1.8 mm	0.0709	# 50	0.0700	
$\frac{3}{32}$ - 48	-	-	0.0937	# 48	0.0760	-	-	
7 BA	-	2.50 mm	0.0983	# 47	0.0785	-	-	
-	-	M 2.50 x 0.45	2.49 mm	2.05 mm	0.0810	# 44	2.20 mm	
-	3-48	-	0.0990	# 47	0.0734	# 44	0.0860	
-	3-56	-	0.0990	# 45	0.0820	# 43	0.0890	
6 BA	-	2.80 mm	0.1102	2.30 mm	0.0905	# 43	0.0890	
-	4-40	-	0.1120	# 43	0.0890	# 41	0.0960	
-	4-48	-	0.1120	# 42	0.0935	# 40	0.0980	
-	-	M 3.00 x 0.60	0.1181	2.40 mm	0.0945	# 41	# 37	
-	-	M 3.00 - 0.50	0.1181	2.50 mm	0.0995	# 39	# 36	
$\frac{1}{8}$ - 40	5-40	-	0.1250	# 38	0.1015	$\frac{7}{64}$	0.1094	
-	5-44	-	0.1250	# 37	0.1040	# 35	0.1100	
5 BA	-	3.20 mm	0.1259	# 37	0.1040	-	-	
-	-	M 3.50 x 0.60	3.49 mm	2.90 mm	0.1160	# 32	# 31	
-	-	M 3.50 - 0.60	0.1378	2.9 mm	0.1142	# 33	0.1130	

This table of British, American, and Metric machine screws and their tap drills has been gleaned from a variety of sources, none of which are guaranteed to be perfectly accurate. In particular there is considerable debate over the 'correct' tap drill to use, hence some alternates are offered. This list is sorted by thread size/outside diameter for convenience in selecting the nearest size in another series.

	British Sizes:	US Sizes:	Metric Sizes (or OD):	Crest Dia:	Tap Drill (75% engage):	Tap Drill Dia. (inches)	Alt. Tap Drill:	Alt. Tap Drill (50% engage):
	-	½ - 28	-	0.5000	¹⁵ / ₃₂	0.4688	¹⁵ / ₃₂	0.4688
	-	-	M 7.00 x 1.00	0.2756	6.00 mm	0.2380	# B	6.40 mm
	-	-	M 7.00 x 0.75	0.2756	6.25 mm	0.2460	# F	6.50 mm
	-	6-32	-	0.1380	# 36	0.1065	# 32	0.1160
	-	6-40	-	0.1380	# 33	0.1130	# 31	0.1200
	4 BA	-	-	0.1417	3.00 mm	0.1181	# 32	0.1160
	-	-	M 4.00 x 0.75	3.99 mm	3.25 mm	0.1285	# 28	0.1045
	-	-	M 4.00 x 0.70	3.99 mm	3.30 mm	0.1285	# 28	0.1045
	3 BA	-	-	0.1614	# 29	0.1360	-	-
	-	8-32	-	0.1640	# 29	0.1360	# 27	0.1440
	-	8-36	-	0.1640	# 29	0.1360	# 26	0.1470-
	2 BA	-	-	0.1850	4.00 mm	0.1575	# 22	0.1570
	³ / ₁₆ - 24	-	--	0.1875	# 27	0.1440	-	-
	³ / ₁₆ - 32	-	-	0.1875	# 23	0.1540	-	-
	-	-	M 4.50 x 0.75	4.49 mm	3.75 mm	0.1476	# 22	4.00 mm
	-	-	M 5.00 x 1.00	4.99 mm	4.00 mm	0.1590	¹¹ / ₆₄	4.40 mm
	-	-	M 5.00 x 0.90	4.99 mm	4.10 mm	0.1610	# 20	4.40 mm
	-	-	M 5.00 x 0.80	4.99 mm	4.20 mm	0.1660	# 16	4.50 mm
	-	-	M 5.50 x 0.90	5.49 mm	4.60 mm	0.1820	# 14	4.90 mm
	-	10-24	-	0.1900	# 25	0.1495	# 18	0.1610
	-	10-32	-	0.1900	# 21	0.1590	# 20	0.1695
	1 BA	-	-	0.2086	4.5 mm	0.1770	# 16	0.1770
	⁷ / ₃₂ - 24	-	-	0.2187	# 16	0.1770	-	-
	⁷ / ₃₂ - 26	-	-	0.2187	# 15	0.1800	-	-
	⁷ / ₃₂ - 28	-	-	0.2187	# 14	0.1820	-	-
	-	12-24	-	0.2160	# 16	0.1770	# 12	0.1890
	-	12-28	-	0.2160	# 14	0.1820	# 10	0.1935
	-	12-32	-	0.2160	# 13	0.1850	# 9	0.1960
	0 BA	-	-	0.2362	5.10 mm	0.2008	# 7	0.2010
	-	-	M 6.00 x 1.00	5.99 mm	5.00 mm	0.1900	# 8	5.40 mm
	-	-	M 6.00 x 0.75	5.99 mm	5.25 mm	0.2067	⁷ / ₃₂	5.50 mm
	¼ - 20	-	-	0.250	# 7	0.2010	-	-
	-	¼ - 20	-	0.250	# 7	0.2010	⁷ / ₃₂	0.2188
	¼ - 26	-	-	0.250	# 4	0.2090	-	-
	-	¼-28	-	0.250	# 3	0.2130	# 1	0.2280
	-	¼ - 32	-	0.250	⁷ / ₃₂	0.2188	# 1	0.2280

British Sizes:	US Sizes:	Metric Sizes (or OD):	Crest Dia:	Tap Drill (75% engage):	Tap Drill Dia. (inches):	Alt. Tap Drill:	Alt. Tap Drill (50% engage):
$\frac{5}{16}$ - 18	-	-	0.3125	$\frac{1}{4}$	0.2500		
-	$\frac{5}{16}$ - 18	-	0.3125	# F	0.2570	# J	0.2770
$\frac{5}{16}$ - 22	-	-	0.3125	# G	0.2610	-	-
-	$\frac{5}{16}$ - 24	-	0.3125	# I	0.2720	$\frac{9}{32}$	0.2812
$\frac{5}{16}$ - 26	-	-	0.3125	# J	0.2770	-	-
-	$\frac{5}{16}$ - 32	-	0.3125	$\frac{9}{32}$	0.2812	# L	0.2900
-	-	M 8.00 x 1.25	0.3150	6.80 mm	0.2660	# J	7.20 mm
-	-	M 8.00 x 1.00	0.3150	7.00 mm	0.2770	# L	7.40 mm
-	-	M 9.00 x 1.25	0.3543	7.80 mm	0.3020	# P	8.20 mm
-	-	M 9.00 x 1.00	0.3543	8.00 mm	0.3160	$\frac{21}{64}$	8.40 mm
	$\frac{3}{8}$ - 16	-	0.3750	$\frac{5}{16}$	0.3125	# Q	0.3320
$\frac{3}{8}$ - 20	-	-	0.3750	# P	0.3230	-	-
-	$\frac{3}{8}$ - 24	-	0.3750	# Q	0.3320	# S	0.3480
-	$\frac{3}{8}$ - 32	-	0.3750	$\frac{11}{32}$	0.3438	# T	0.3580
-	-	M 10.00 x 1.50	0.3937	8.50 mm	0.3346	# Q	8.45 mm
-	-	M 10.00 x 1.25	0.3937	8.80 mm	$\frac{11}{32}$	$\frac{23}{64}$	9.20 mm
-	-	M 10.00 x 1.00	0.3937	9.00 mm	0.3543	# U	9.40 mm
-	-	M 11.00 x 1.50	0.4327	9.50 mm	$\frac{3}{8}$	# X	10.00 mm
$\frac{7}{16}$ - 14	-	-	0.4375	$\frac{23}{64}$	0.3594	-	-
-	$\frac{7}{16}$ - 14	-	0.4375	# U	0.3680	-	-
$\frac{7}{16}$ - 18	-	-	0.4375	$\frac{3}{8}$	0.3750	-	-
-	$\frac{7}{16}$ - 20	-	0.4375	$\frac{25}{64}$	0.3906	13/32	0.4062
$\frac{7}{16}$ - 26	-	-	0.4375	# Y	0.4040	-	-
-	$\frac{7}{16}$ - 28	-	0.4375	# Y	0.4040	# Z	0.4130
-	-	M 12.00 x 1.75	0.5512	10.30 mm	$\frac{13}{32}$	$\frac{27}{64}$	10.90 mm
-	-	M 12.00 x 1.50	0.5512	10.50 mm	# Z	$\frac{7}{16}$	11.00 mm
-	-	M 12.00 x 1.25	0.5512	10.80 mm	$\frac{27}{64}$	$\frac{7}{16}$	11.20 mm
-	-	M 12.00 x 1.00	0.5512	11.00 mm	0.4331	$\frac{7}{16}$	11.40 mm
$\frac{1}{2}$ - 12	-	-	0.5000	$\frac{13}{32}$	0.4062	-	-
-	$\frac{1}{2}$ - 13	-	0.5000	$\frac{27}{64}$	0.4219	$\frac{29}{64}$	0.4531
$\frac{1}{2}$ - 20	-	-	0.5000	$\frac{7}{16}$	0.4375	-	-
-	$\frac{1}{2}$ - 20	-	0.5000	$\frac{29}{64}$	0.4531	$\frac{15}{32}$	0.4688

Sources:

Alan E. Frisbie, Flying Disk Systems, Inc; 4759 Round Top Drive, Los Angeles, CA 90065.

Frisbie@Flying-Disk.Com; (213) 256-2575 (voice); (213) 258-3585 (fax)

AND: Russ Kepler, at home: **russek@swcp.com**



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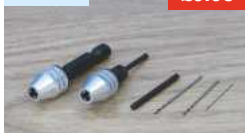
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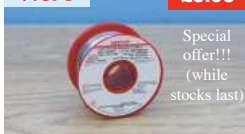
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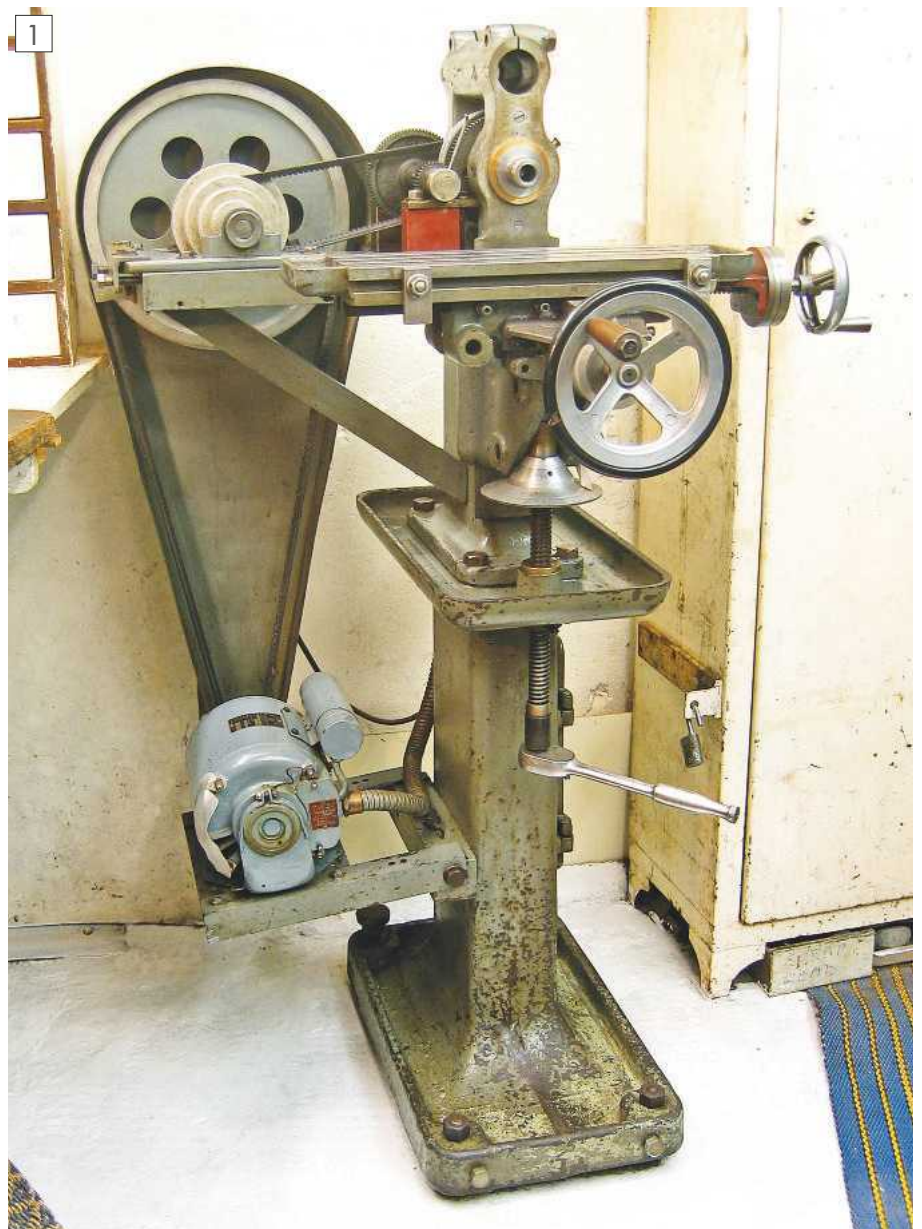


A bit of history

Back in the 1970s I was looking for a horizontal milling machine to augment my workshop. Not long before, I had acquired an old Myford ML7, used previously mainly in the construction of clocks. Therefore, there was little apparent wear from cast iron dust, steel swarf etc. It was covered in what looked like shellac, so I decided to dismantle, clean, and check it for wear – of which there was very little. It was repainted and reassembled.

The Trident C Milling Machine, which I found for £50 was in a sorry state. Recently I found that mine of information, www.lathes.co.uk Looking under Pallas Millers, Model C Miller, I discovered that the Model C was manufactured from the late 1920s and was originally flat belt driven and with rack and pinion feeds on all three axes. There were screw feeds on the cross and vertical travels. By the time I bought it, the rack and pinions had been removed, and a screw feed had been applied to the knee slide, but annoyingly with a left hand thread. A previous owner had converted it to V belt drive with a motor bracket and lay shaft on hefty angle iron frames on the left hand side of the machine.

Photograph 1 shows it after the initial improvements but before the current refurbishment was started.



Trident C horizontal mill.

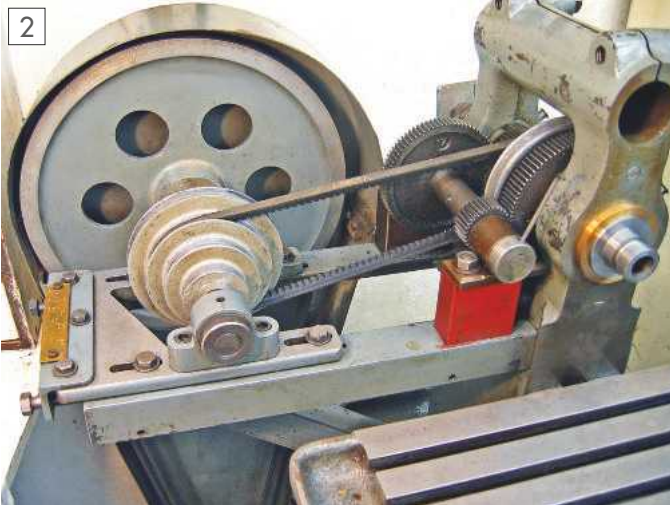
The Miller's Tale

In the latest of our sequence of articles on restoring vintage milling machines, the Revd. Ian Strickland recounts the story of the magnificent Trident Mill he brought to the 2014 Model Engineer Exhibition.



The initial improvements were to add a back gear with two large stout cast iron gears culled from an ancient machine, but two smaller steel gears had to be made to complete the back gear, which gave a reduction ratio of 6.47:1. The speed reduction was about right, but only

gave me three extra slow speeds, as the fastest back gear speed was more or less equal to the slowest open speed. More importantly, it gave lots of torque at low revs (**photos 2 & 3**). Open speeds ranged from 560 rpm to 70 rpm. In back gear the slowest speed was 12 rpm!



General view of belt drive and back gear.



Back gear from RHS.



Bracket and micrometer dial (Y axis).



Ex WW1 gunnery level which reads to 1 minute of arc, about 0.001 inch in 5 inches.

Terminology

Modern parlance refers to X,Y and Z-axes on various machine tools like horizontal and vertical milling machines.

On a horizontal milling machine:

- The X-axis is the left and right movement of the table.
- The Y-axis is the front to rear movement of the table.
- The Z-axis is the vertical movement of the table.

Reference to SK.1 of Harold Hall's article 'KnowYour Mill' shows this clearly (**ref 1**).

These axes must all be perpendicular with respect to each other if accurate work is to be achieved, i.e., ideally better than 0.001 in 12 inches.

To improve ease of use of the Trident mill, other modifications shortly after purchase included:

1) A new welded up support for the knee feed screw (Y-axis), which also covered the top of the knee slide to protect it from swarf. A larger, somewhat DIY, wheel handle was added. An adjustable micrometer dial was added to a new right hand threaded 10 tpi feed screw (**photo 4**) and the top surface of the knee was squared up with respect to the vertical slide by careful filing and checking all was level with a WW1 gunnery level (**photo 5**).

It measures to 1 minute of arc, which if my trigonometry is correct, represents 0.0015 in 5 inches, which is the length of its base. It is quite difficult to use, as the bubble is very sensitive.

2) An extended support was made for the table feed screw (X-axis) and hand wheel, and the micrometer dial made adjustable (**photo 6**). Friction being provided by a plug of leather compressed by a grub screw, in the fixing hole.

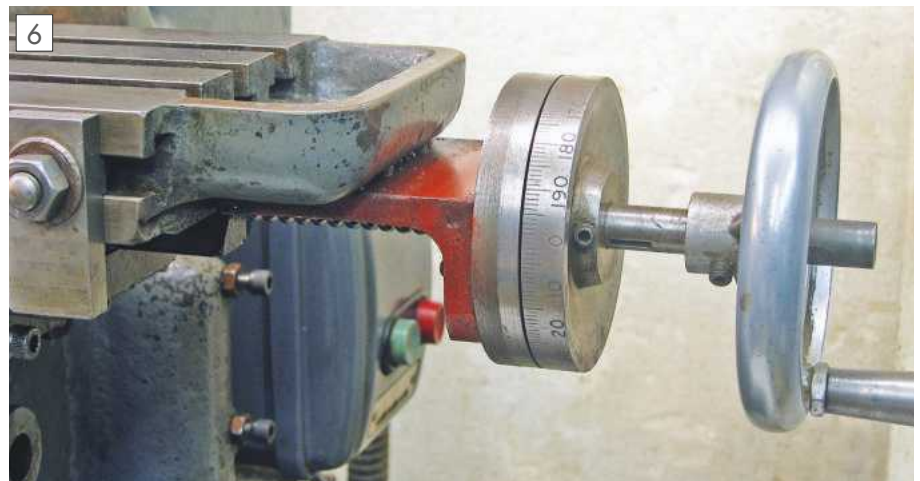


Table feed with extension (X axis).

3) The awkwardly placed handle wheel on the bottom of the vertical screw (Z-axis) was replaced with a spare ratchet handle from a socket set (**photo 1**), and another adjustable micrometer dial was added just below the knee carved out of a Picador aluminium pulley (**photo 4**). Friction adjustment was also provided by leather plugs compressed by grub screws, but this time four of them at 90° equally spaced around the vertical screw.



Machine number and Myford spindle nose thread.

All of this was a great improvement in user friendliness, but the spindle nose thread did not match the Myford. So in the 1990s a second go at improving this sturdy old machine was put in hand. The spindle bearing surfaces were found to be badly scored, so these were skimmed and new bronze bearings installed. The front bearing is double tapered and was a bit of a headache to get right, but persistence eventually paid off.

The machine number is stamped on the front slide just above the main bearing, but can anybody tell me whether the '43' relates to the year of manufacture? If so, it is the same age as me! Also what are the two ½ inch BSW tapped holes for, above and below the bearing? **Photograph 7** shows the new Myford sized spindle nose, new front bearing and the two ½ inch BSW holes.

In use it was very apparent that the various slides, the X & Y-axes in particular, were not at right angles with each other or to the spindle axis. The dovetail slides were tight at the ends of their travels indicating uneven wear. Also the spindle alignment was offset.

And so we come to the present project.

Being retired now, time is no longer an issue, and on grounds of cost, there was no

question of having the mill professionally refurbished. Furthermore, I was anticipating the satisfaction of truing up and refurbishing the mill at minimal cost.

I started by trawling through back numbers of *Model Engineer* for inspiration and found several helpful articles on milling machine and lathe refurbishment etc. These are listed at the end of this article (**refs 2 - 5**). The most relevant, was an article by D. J. Unwin back in 1977 (ref. 3) on refurbishing an old milling machine with basic tools. The first part dealt with truing up the various slides, and how to measure the dovetails, but not too much was said about how to establish the amount of the errors.

When I first started to refurbish my mill, I found, in a machine tool book, a page of diagrams for Testing Industrial Knee-Type Milling Machines. It dealt with such matters as spindle truth, levelling of the table, truth of lateral table movement etc. There was also a table of permissible errors for the major axes etc., typically better than ± 0.0008 in 12 inches, (0.02 in 300mm) (Harold Hall refers to BS 4656-3:1971 & BS 4656-4:1971 in which the permissible errors are 0.025mm in 300mm – 0.001 in 12 inches, ref 1.), so my target was ± 0.001 in 12 inches.

As I am of the old school I don't think in metric, so all dimensions henceforth I have given in Imperial units. Also my workshop is Imperial. However I do possess a modern digital micrometer and vernier gauge which both can be switched between metric and Imperial units. Very handy when working from metric drawings etc.

My purpose in putting pen to paper, or fingers to keyboard, is firstly to give something back to our hobby, as I have learnt so much from other contributors to *Model Engineer* over the years, and secondly to encourage others to have a go at improving their machines. Although my example is of a horizontal milling machine, the principles can be adapted to other machine tools. I have deliberately gone into some detail, as the sources I found left out a lot of the 'words and music' about how to establish the errors and how to do some parts the job. I have therefore used a 'step by step' approach, which I trust will be of help to those who may, like me, do not have an engineering

background. Also I have learnt a lot by just doing it, and making mistakes.

All of the tools or equipment used are not expensive, but you will need a good clock gauge (DTI - dial test indicator); a 7 or 8 inch engineer's square; a set of feeler gauges; a micrometer or two; or a good digital caliper gauge; a micrometer head; some new fine files; marking blue; double sided self-adhesive tape; various grades of wet and dry abrasive paper; a surface plate – mine is a piece of ¾ inch thick plate glass from the local glazier; a tube of marking blue; and a few other things mentioned as the description proceeds. A gunnery level is not essential, I just happened to have one.

The latter part of the refurbishment will entail using the milling machine itself to rebore the column for the spindle bearing housings and the bore for the overarm.

Preliminary Tests

Test 1, the front of the vertical slide (Z-axis) is the reference surface, so checks for alignment started with the overarm which was about 0.006 in 6 inches out of alignment in the horizontal plane (**photos 8 & 9**) and **test 2** was slightly high vertically by about 0.003 in 6 inches (**photo 10**).

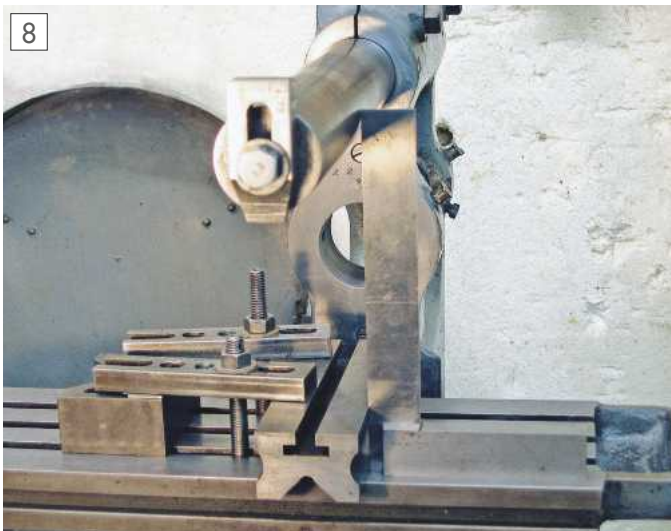
Test 3, the table alignment from left to right (X-axis) was checked with the DTI against the face of the vertical slide and also found to be about 0.005 out in 6 inches in the horizontal plane.

Test 4, the table surface was checked for squareness with the vertical slide in the vertical plane, and found to be no more than 0.0015 out in 6 inches (**photo 11**).

Lastly test 5, the front to rear alignment of the knee slide in the horizontal plane (Y-axis) with the face of the column was checked, and found to be out by at least 0.005 in 4 inches (**photo 12**).

As all the slides were tight towards the ends of travel, this suggested that the dovetails were wider at the ends than the middles.

Photograph 10 was taken after dis-assembly as it was easier to check the overarm with the column on its back. You may just be able to see the increasing gap between the overarm and the square. Photograph 12 was taken mid-way through truing up the knee slide.)



Test 1. Temporary reassembly to check overarm alignment.



Test 1. Checking alignment of overarm.



Test 2. Checking alignment of overarm.



Test 4. Checking squareness of topslide to vertical column face.



Test 5. Checking squareness of X axis with front of column.

Stage 1

The machine was taken apart, cleaned and the main column laid on its back. Use of the flat surface with marking blue showed that the column surface was worn concave by about 0.003 inch. Using this and a straight edge confirmed the situation. Initially the high areas were abraded away by lapping coarse carborundum grit (left over from stone polishing) with a lump of cast iron about a 12 inches long, 5 wide and about 1.25 inches thick, seen at the bottom of **photo 13**. It had been a flat iron in a previous life, and its sole was really quite flat. When the bluing indicated flatness was much improved, a switch to 400 grade (fine) grit was made. White spirit was used as the lubricant, rather than oil to reduce the drag. Lapping with grit produces a dark grey matt surface. This was brightened up by rubbing the surface with a medium diamond lap (**photo 14**). It was then easier to see where the blued high spots were, to be removed by scraping.

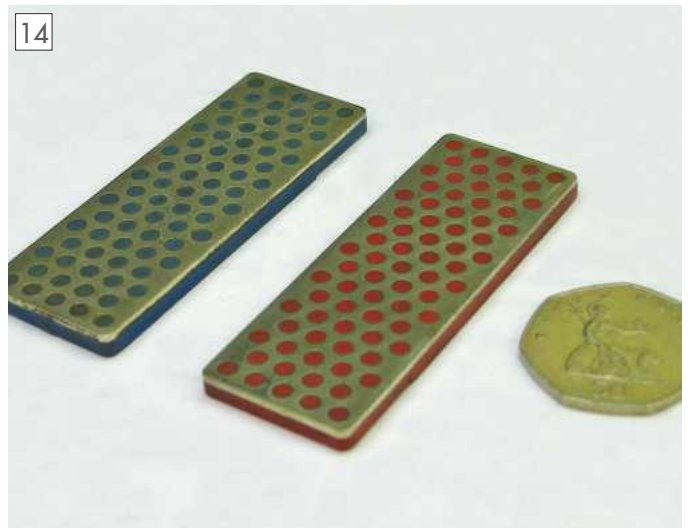
Scraping

Another trawl through *Model Engineer* produced several articles about scraping, or refurbishment of lathes etc., using said method (**refs 6 & 7**). Scraping could be described as a finishing process, but initially metal can be removed much more quickly with a new fine flat file, again finding the high spots with marking blue paste. Not to be confused with marking out blue, which dries quickly, and as the name implies is for marking out.

I have to say that scraping requires a fair degree of practise, and the scraper needs frequent touching up, which is time consuming. Contrary to the expert's advice, I found it easier to use a curved bearing scraper and scrape towards one, rather than a straight scraper, which is pushed away from one. I wondered whether the tool steel of my shop bought scrapers was sub-standard. I re-heat treated the straight scraper which improved its hardness somewhat, but it



Scraping / lapping in progress to face of column.



Course and medium diamond laps.

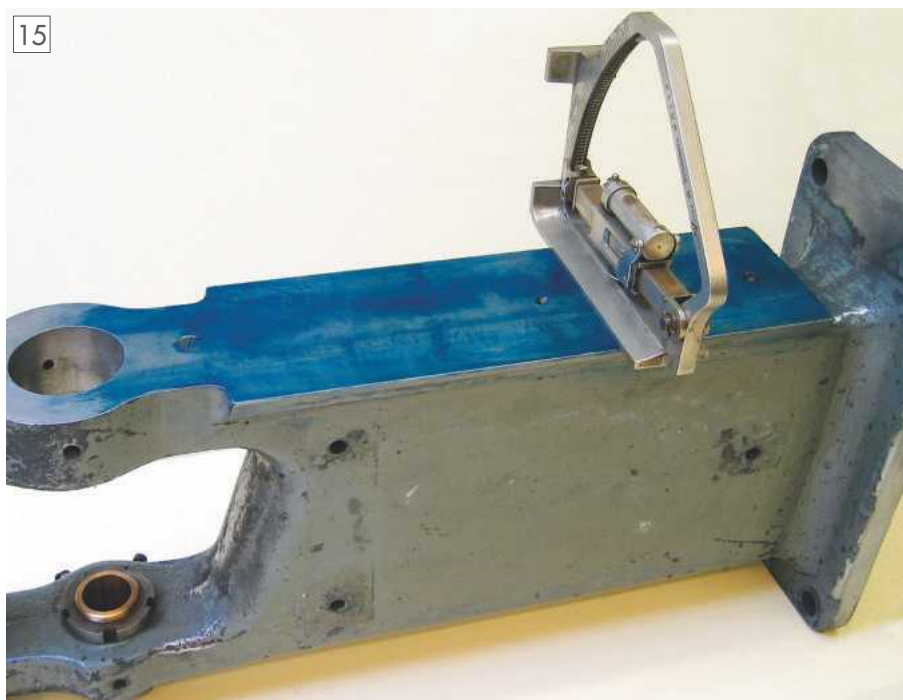
still was taking a long time to restore its cutting edges between sessions.

Rather than give a blow-by-blow account of how to scrape a surface, I refer the reader to one of the many publications such as Ian Bradley's book *The Amateur's Workshop*. He also produced an article for *Model Engineer* (ref. 6). Whilst I have no doubt that scraping is a time honoured method of truing up surfaces, for me, a rethink of the metal removal process was needed. Using loose grit is messy, the grit gets everywhere and it was difficult to get the surfaces completely clean before re-applying the surface plate. The slightest particle of grit upset the transfer of the marking blue from the glass to the metal, and scratched both surfaces. The use of small diamond laps was resorted to next. I have three of these (photo 14) about 3 inches long, in coarse (325 grit), medium (600 grit) and fine (1200 grit). Work started with the coarse lap first. This removes metal more precisely, but rather slowly, and as they are pretty flat it is relatively easy to attack the high spots. However, it was quicker to use a fine sharp file to remove the bulk of the metal, and then to tidy up the surface with the coarse diamond lap before rechecking with the flat surface and marking blue. The lubricant for diamond laps is water, to which a squirt of washing up liquid was added to help clean off the oily marking blue with the aid of an old toothbrush. Every now and then cream kitchen cleaner, such as Jif, had to be used to get them and the toothbrush really clean. As the diamond is captive in the surface of the lap, cleaning up was much easier before rechecking progress with the surface plate.

Checks for twist in the vertical face were made using the gunnery level but at right angles to the Z-axis (**photo 15**) and also by swinging the DTI from one place in the centre of the column. Twist was less than 0.001 inches.

To be continued...

15



Checking Z axis for twist.

REFERENCES

1. 'Know Your Mill', by Harold Hall, *M.E.W.* 143, October 2008, p 12.
2. 'Overhauling the Lathe', by B.J.Whitehead, *M.E.* 3519, 15 August 1975, p 800, and 3520, 5 September 1975, p 865.
3. 'A Milling Machine Story' by D.J.Unwin, *M.E.* 3561, 20 May 1977, p 584, and 3562, 3 June 1977, p 620.
4. 'Restoring an Old Lathe', by C.L.Barter, *M.E.* 3812, 6 November 1987, p 518.
5. 'Renovating an Old Lathe', by Dave Lammas, *M.E.* 3830, 5 August 1988, and 3832, 2 September 1988, p 289.
6. 'Scrapers and Scraping' by Ian Bradley, *M.E.* 3720, 6 January 1984, p 40, and 3723, 17 February 1984, p 184.
7. 'Hand Scrapers', by Les Oldridge, *M.E.* 3817, 15 January 1988, p 110.

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One Man and his Lathe

John Calnan and his Harrison 250



For the last 10 years, the most favored tool in my 'man-cave' has been a Harrison 250. However, I have been involved with lathes since I was a teenager, becoming committed when I spent two 3 month periods of my 5 year apprenticeship on lathes. The first spell was on a Ward capstan bar lathe and my second was as the assistant on a batch of automatic capstans. I thought that these 'peg drum' autos were magic, in that they were my first encounter with machines that worked on their own! From the start of my apprenticeship I developed parallel engineering activities at work and at home. The latter mostly involved motorcycles and cars, but it wasn't until the 70s that I invested in my first lathe. I looked at a few before settling on a Colchester Master - the round top type which was then about 25 years old. I found it in a machinery dealer's shed, which was mainly stocked with much larger machine tools. I remember asking the dealer the weight of the Master and I quickly discovered that his estimate of 7 cwt was out by a factor of two. This was dramatically demonstrated when his gantry crane lowered it onto my motorcycle trailer, which was obviously then somewhat overloaded! However, my trailer survived the short journey home, and I soon fitted the Master with a single phase motor and put it to work on the current motorcycle project.

I kept it for the next 28 years, whilst expanding its capabilities with a Dickson quick change tool post and a number of chucks and other tooling. I quickly learnt that the cost of tooling and accessories can easily exceed that of the original purchase and this has been reinforced with my involvement with subsequent lathes, milling machines and other tools.

One thing that I found unsatisfactory with powerful single phase motors was the load that their 'instant' acceleration characteristic put on the gear train of a lathe. I tried a couple of remedies, but neither was particularly satisfactory. I fitted the Master with a shot ball drive coupling, where the rate of taking up the drive is varied by adding or removing shot from the casing - the device looking and acting like a rather crude fluid flywheel. This certainly took away the worst of the bite on switch on, but I could not achieve anything like a soft start. Many years later, on my Harrison 250, I fitted the motor with a flywheel to try and slow down the acceleration and to reduce the noisy vibration that the motor induced in the



Corner of workshop showing 250 and Master in the far corner.

gearbox, when running at its rated speed. It seemed to make little difference to the acceleration, but significantly reduced the vibration, which had previously made some gears unusable.

After about 10 years of relying on the Master, I moved to a house where I could build a larger home workshop and I decided to add a smaller lathe. My first purchase was a Boxford, which was obviously a quality lathe and in good condition, but I found that the absence of a lever controlled gearbox discouraged usage. Battling with belts to alter speeds, or finding and fitting suitable change wheels (and the lathe only came with a small selection) discouraged using that lathe on many of the planned smaller jobs. Fortunately, after a couple of years, someone living quite near offered to buy it and so I was again on the search, but this time determined not to buy anything that involved fiddling with belts. A review of the stock at a local dealer (an Aladdin's cave that has since been replaced with blocks of trendy flats) and a Bantam was soon loaded onto my trailer. As with the Master, I fitted it with a single phase motor and a Dickson tool post. It quickly became the lathe that I chose to use, with the Camlock chuck fittings bringing unexpected benefits after the odd taper

and 'back nut' attachment of chucks on the ancient Master.

It was at about this time that I made a big mistake, which was big in two ways, but fortunately not in cash terms. At the time I was machining some large items (including bell housings to mate diesel engines to different gearboxes) and I decided that I would benefit from a large lathe to save having to beg time on friend's equipment. Fortunately, I found a big old Harrison in a friend's garden and persuaded another friend to collect it on his company's car trailer. After the inevitable fitment of a single phase motor (a cheap Taiwanese one) I used it on a number of larger jobs for a couple of years, but began to realise that it was an 'elephant' in my workshop. I decided that I could make much better use of the space and found a friendly local farmer who was keen to have it in a corner of his barn - I was delighted to see it set off up the road on his trailer.

Soon after this, finances were sufficient to allow for the something like 60 year old Master to be exchanged for one that was then less than 10 years old. This was a dramatic change since it came with a Newall DRO and apart from fitting a single phase motor, has run happily for the last 15 years (**photo 1**). It did not suffer the

instant motor start problem, since it is fitted with a clutch. However, that lathe is not the main subject of this article, which concerns the smaller of my two lathes.

I was then settled with the Master and the Bantam, with 90% of tasks being allocated to the latter, and I made no further changes for about 10 years. However, the previous owners of the Bantam had used it in an electric motor repair business and the bed had suffered significant wear. I investigated having the bed reground, but was discouraged, not only by the cost, but by the major effort that would be involved in dismantling, delivery and collection from the grinders, and subsequent rebuild. So I decided to sell it and find something similar with a much better bed.

I had invested in a few bits of tooling at machinery auctions and began scanning their listings to check for small lathes. I soon spotted a Harrison 250 at a sale in South Wales (**photo 2**) and thought it worth a visit to try and assess its quality and wear. It seemed okay, if rather lacking in tooling – only one chuck and one tool holder on a Dickson tool post. However the bidding stopped with me and I collected it a few days later on my trailer. A short stop at a friend's workshop allowed us to connect up a 3 phase supply and prove that it was at least 'quiet in all gears'. An advert in *MEW* produced a buyer who was happy to accept the inaccuracy of the Bantam.

Although I was only able to give the Harrison a visual check at the auction, it has proved to be pleasant to use and has no significant wear. I fitted it with a single phase motor (1.1 KVA) and having been spoilt with the DRO on the 'new' Master, I fitted a similar Newall system to the 250. As so often described in this magazine, the task was quite challenging and tedious, but well worth the effort – whatever did we do before we had such kit! The vibration problem that I mentioned above was annoying, but fortunately was absent at my favourite speed of 500 rpm. However, it was all eliminated with a change to an inverter and 3 phase motor, as described in *MEW* 210 (Dec 13). This has now worked like a dream for 2 years and has quite transformed the lathe.



My Harrison 250.

After World War 2, Harrison and Colchester introduced similar ranges of lathes, with Harrisons in Yorkshire and the Colchester Co in Colchester! Both companies had their loyal followers/ buyers and their lathes were developed over the following 20 plus years, both cosmetically and in their capabilities. My 250, which I believe is a later model, has

an all geared head giving 9 speeds from 40 to 1500 (although these are now of course, infinitely variable with the 3 phase motor and inverter drive) a screw cutting gearbox, giving a good range of metric and inch threads, together with separate power feeds to saddle and cross slide. The swing over the bed is 12 inches and the chucks are secured with the excellent camlock system.

I instantly equipped the 250 by moving over a lot of the tooling from the Bantam. Despite using it several times a week for the last 10 years, I have not found the need for many improvements apart from adding the DRO and changing the motor. One modification that I have found beneficial is that after fitting a single phase pump to the coolant system, I modified it to support the 2 lathes. Both lathes drain into the one tank and I fitted taps to the pump output to direct the flow to the in-use lathe (**photo 3**). I do not use coolant that often but the modified system reduces the tendency for the soluble oil mix to deteriorate.

The need to have the 250 almost constantly available has discouraged me from tackling the only defect that has developed. This is its failure to trip when the saddle runs up against the bed stop. I fear that curing this would involve moving it away from the wall and undertaking some serious dismantling to gain access to the mechanism inside the saddle. I will eventually have to tackle it,



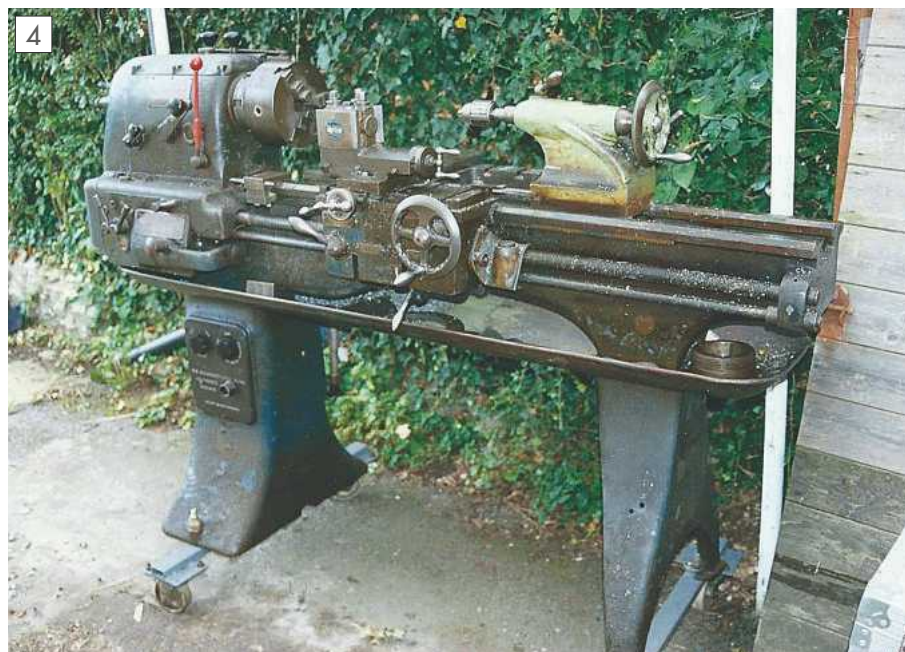
Communal coolant tank.

Although I have a reasonably equipped workshop, it is my Harrison 250 that is at the heart and which is the most used. In its present form it will certainly outlast me and should give another user many years of faithful service.

but in the meantime I keep my hand poised to trip the lever as the saddle reaches the stop. Of course, setting the DRO to zero at the bed stop position is a major help.

Although I am currently reluctant to move the 250, I developed a system of moving my lathes on casters, as soon as I got the first one home. I invested in some casters at that time and have used the same set ever since, on different mountings to suit the lathes and on the frame of an engine/GP crane that I constructed about 30 years ago. Lifting the lathe ends with a bottle jack was easy with the old Master with its frame design and **photo 4** shows this lathe on casters. I have had to fabricate suitable brackets for later acquisitions.

I have a good range of tooling, including 3 and 4 jaw self-centring chucks, 4 jaw independent chucks, a face plate and a



Old Master on casters.

good selection of tool holders. Some of these holders carry throw-away tipped tools, but I still do a lot of turning with hand ground high speed tools. One exception is parting off, where I use a technique which I have not seen mentioned in any of the many MEW articles on parting off. Many years ago, I made a couple of holders to mount tipped parting off tools upside down, which of course involves running the work in reverse. I have found that this method (**photo 5** shows the 250 holder) has resulted in few disasters!

I should explain that although I have been active in an expanding home workshop for nearly 60 years, I am not a model engineer. For many years I was

constructing motorcycles and modifying cars (mainly in fitting diesel engines before they became so good in production form) but more recently in developing remotely operated vehicles. These have mainly been for use in hazardous situations (with nuclear or explosive risks) and one of these is shown in **photo 6**. I have also undertaken all the machining on a research project that I embarked on with two colleagues, to develop a self-loading electric wheelchair.

Although I have a reasonably equipped (and somewhat cluttered) workshop with turning, milling and welding equipment, it is my Harrison 250 that is at the heart and which is the most used. In its present form it will certainly outlast me and should give another user many years of faithful service. ■



Parting off tool in holder.



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More on the Mystery Machine

G'day Neil, I've only just got my copy of *MEW* 226. There is always something to keep me interested in your mag.

The Mystery Machine in Scribe a line page 37 is a much modified mate for a lathe that I've owned for nearly fifty years, two lead screws and all. Some one has added a massive head stock bearing extension to the Mystery one, and bolted it to a ?railway sleeper?

But it is the same lathe. I have seen several on this plan some quite small, and one that must have been 8 feet long. My lathe has a 4-foot 4-inch bed and is still treadle powered.

It has 'made by W.F. & J. Barnes Co. Rockford Ill. USA No.5 cast on the legs' and 'Pat. Sep./12/1880 & Pat. Feb./15/1887' cast on to the bed. In the foreground of the catalogue picture is engraved - FREEMAN ENG. ROCKFORD.

So I guess that it may have been a good design copied by many makers - As Southbend lathes were copied by Boxford in UK and by Hercus and Sheridan here in Australia, or the company just changed hands.

I hope this has been of some help.

Robert G. Bonham
Shoalhaven NSW. Australia



CNC Confusion

Dear Neil, I am sorry for bothering you with my problem and I hope that there will be an easily found answer.

I have developed an interest in CNC programming and I have used articles from your magazine to further it.

In number 163 of *MEW* you ran an article entitled 'CNC Milling, using Subroutines to aid Machining of multiple parts' which I found very interesting.

Unfortunately, I am unable to run the program as published due to an error message and I wonder if there is an error in the listing.

I have tried searching your site but I have had no luck.

I wonder if you have any indications from other readers concerning this listing and if so I should be very grateful if you could let me know.

Peter Nettleton, by email

Lost in Translation?

Dear Neil, I have an imperial Myford but find that I am increasingly using the metric system for turning, so have to do conversions from imperial to metric which takes up time and I don't always get it right. Do you know if an electronic gadget is on the market to do the sums, a thing like a pocket calculator? I have an electronic vernier that does convert but am looking for something I can put in my pocket. I haven't spotted anything on the internet that would do the job. I enjoy reading *MEW*.

Neil Macnaughtan, Edinburgh

Suggestions for a Small Drill Kit

Dear Neil, I am writing to ask if you can suggest where to get help with my proposed project to build a smallish pillar drill. I enquired at Stuart Models who have a kit which I saw at the recent Harrogate Show but it is only 9 inches high and at my age such small detailed work is not easy. Do you know of any companies which produce a kit for something a bit larger? Any help to point me in the right direction will be really appreciated.

I look forward to your monthly magazine with high hopes of finding something to make which suits my limited ability but so far not much luck.

I live near Glasgow and most of what interests me seems to be in the south of England.

Ian Gemmell



Satisfied Reader

Dear Neil, Thank you for sending me the spreadsheets. I find *MEW* a wonderful magazine and I have taken it continuously since the first issue. As soon as it arrives I usually eagerly 'devour' it from cover to cover. It and back copies usually accompany me on holidays, as essential re-reading! (Together with *ME* et al, dare I say.)

Like many others, I enjoy making things in metal etc. but lack formal engineering training. However, I have learned an immense amount over the years from reading these publications and owe much to the article authors and all the past Editors and their staff too.

I never cease to wonder at the constant stream of fascinating articles and the on-going diversity of the subject matter. There is such a wealth of ideas in past issues as well that I suspect numerous younger devotees of the hobby probably miss out by not accessing these. Take for example the saddle stop that was featured some few months prior to August 2006. I managed to construct one for my Myford lathe, based on the author's article, back in 2006. As a permanent attachment for the lathe, it is in frequent use and a joy to have on the lathe. Surprisingly, I have seen no reference to the article since, although in my opinion the author deserves praise for the design of this neat saddle stop, even if some may say it is a bit over-engineered. Nevertheless, for me it has been well worth building. Maybe you might even consider reprinting the article sometime.

The photo was just intended for my own records and you would never guess from the swarf strewn lead screw, (must re-do the photos sometime after a clean down), that I am a George Thomas admirer, and have incorporated his design of stop for my Myford top slide for instance. His authoritative *Model Engineers Workshop Manual* is high on my 'always keep handy' book list. How GHT ever had enough time out of his workshop to write the book and do all those engineering drawings, is a mystery.

One photo shows a posed set up of the how the bar along which the saddle stop, body slides, was made level for marking the position of the fixing screws into the lathe bed casting. (because of the inevitable irregularity of the as cast surface, a



facing cutter had first to be made in order to cut seats for the individual spacing washers of the correct thickness, to hold the bar just off the bed.) The suds tray is deliberately off level (as the bubble shows), but the bed is level of course, making it tricky to support the left hand end of the bar during the spotting through process. Not evident in the photo, is the extent of the lateral projection of the bed's feet, compared with the much narrower region under the slideways. A cantilevered support was called for. Fortunately, help was at hand in the form of Harold Hall's lathe tool height setting gauge which I happened to have made a few years previously. Being adjustable and having the necessary projection over its base, it was ideal for the job.

Harold was absolutely right in his original construction article, how once made, the device will be much used. If the *Model Engineering* world were to award the equivalent of an Oscar in recognition for contribution to the understanding of metal working and allied fields, among amateurs like me, my vote would definitely be for Harold Hall.

Tim Sims, West Midlands.

Circuit Conundrum

Dear Neil, whilst reading the very interesting article for simple speed control of DC motors in magazine no 229, I notice that in figure 4, page 32, TR2 BC327 is shown as an NPN transistor when in fact it is a PNP. The circuit description in the text is all correct but the diagram, I believe, is not; the circuit does not work as drawn. I am still, after 25 years, trying to learn the basics of electronics so I spotted this as I tried to

make sense of the text in relation to the diagram.

The hard part for the home constructor will be to make the PCB. A good alternative would be strip board but with the TR3 drain and source connections to motor and GND being made directly with wire since strip board current capacity may be too low.

Great article and great magazine.

Richard Hughes, by email.

Thanks to Richard and the many other readers who spotted this error, which was ours in redrawing the original diagram. A corrected version has been printed in this issue. Several other readers have suggested adding a 'flywheel diode' across the motor switch, to protect the circuitry from inductive spikes. Anyone wishing to do this should ideally use a shottky type diode.

Neil

We would love to hear your comments, questions and feedback about MEW
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How Things Have Changed



Emeritus editor of MEW, Dave Fenner, reflects on how hobby engineering has evolved over the magazine's 25 years.

Our current editor kindly suggested that I offer a few thoughts on how our hobby has developed over the last quarter century. What follows will be based on a hopefully well informed, but nevertheless personal view. My own direct involvement with a home workshop began in 1978, somewhat more than 25 years ago, with the purchase of a well worn Myford ML7 and a Black and Decker drill on a stand, both installed at the rear of the garage. For the purposes here, it may be useful to categorise the musings into Machines, Accessories, Measuring, Draughting, Processes, Materials and Models. I would guess that the principal drivers for change in each category, have been the advances in technology in mainstream industry, which have, in turn, either read across to, or influenced the production economics and the availability of hobby equipment.



Myford Super 7 here fitted with Newton Tesla inverter variable speed control.

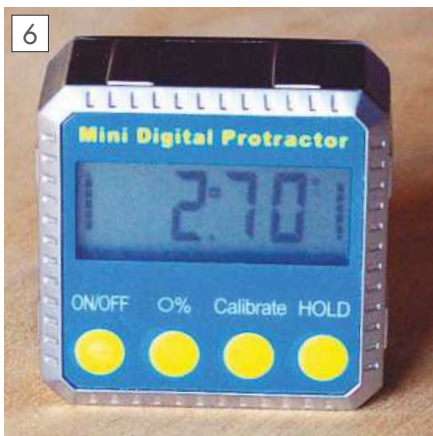
Machines

From the 1950's, there was a limited choice of usually UK built hobby machinery, and certainly the Myford ML7 and Super 7 (**photo 1**) were pre-eminent. With the range of available accessories, they allowed turning, milling and grinding all to be undertaken by just one principal machine within a small footprint. Industrial machine tools have been built for long service, and examples of various sizes, could often be found at attractive prices, though many of these would have been hard worked in a factory setting. With rising prosperity, came the desire for a dedicated milling machine. It was probably around 1980, that we first started to really see imported workshop machinery from China, and these had made great advances by 1990. Early imports were sometimes denigrated for containing quantities of moulding sand, but in general with careful setting up, would give good performance. My first experience with one of these was with a Naerok mill/drill (**photo 2**), which I used first domestically then commercially with great success for over fifteen years. One disadvantage with the mill drill style was the loss of head registration when the head was raised or lowered on the round column. Means of dealing with this were offered in *MEW* over the years, initially using a key solution. Later, lasers came on the scene, and provided an alternative route to accuracy. The 21st century saw the arrival of various examples of a revised



Naerok Mill/drill in use for gear cutting.

configuration of mill, on which the head assembly could slide vertically on a dovetail column thus solving the registration issue. Some variations also featured a tilting head. In the mid 80's, items such as the Toyo lathe, and the ubiquitous 4½ inch band saw became available. Scanning quickly through a couple of the very early issues of *MEW* (Summer, Autumn 1990), adverts may be found for the Diamond fretsaw,



Digital angle gauge.

been that they can be upset by the ingress of coolant. A premium range of glass scales is now shown in the Arc catalogue which 'provides adequate protection against swarf and coolant'. A two axis system of this type might cost around £400 and would be directly comparable with my £1100 system of the 90's.

Following on from the advances in linear measurement, we also now have digital angular devices, again at relatively low cost. The digital angle gauge shown in **photo 6** which has a resolution of 0.1 degree, is an example.

One disadvantage of the modern devices concerns battery life, especially in cold conditions. While I do have two digital callipers covering up to 12 inches (**photo 7**) for most quick checks, I usually reach first for an old Mitutoyo vernier caliper (**photo 8**) which is always ready for action and easy to read to an accuracy of 0.1mm - and never needs a battery.

Draughting

When I started my own business back in the late 80's, all drawing work was carried out on a full size drawing board with traditional parallel motion. At around the same time, friends involved in high tech work had started using CAD (computer aided draughting). I can remember them saying that on occasions you could go for a cup of coffee while the computer caught up with the changes. It was during the tenure of Harold Hall, (who took over the MEW editorial chair from Stan Bray) that CAD



Two digital callipers, cheapo 6 inch and pricier Mitutoyo 12 inch.



Vernier callipers never need a battery.

really came into the pages of the magazine, and it provoked quite a reaction from the traditionalists. Over the years, computing power has vastly increased and along with data storage become cheaper. Also the cost of CAD software has come crashing down so that whereas earlier high end software would cost thousands and even a budget version might cost between £50 – 100, nowadays much is available free of charge.

More recently 3D systems have begun to make the transition from high end industry down the food chain, and we are seeing more evidence of this in the rendered isometric illustrations in *MEW*. Three dimensional drawings are also the starting point for designs intended for additive manufacturing, of which more below.

Processes

Where the essence of metal cutting is concerned, it may be argued that little has changed over the last 25 years, or even the last century. We have though, seen the move from carbon steel tooling, to high speed steel, then carbide even diamond. Abrasives have seen similar advances and cost reductions. A diamond wheel is ideal for sharpening carbide tools and that shown in **photo 9** was supplied by Eternal Tools. It is another example of something historically reserved for industry now becoming affordable for amateurs.

Two other cutting processes are plasma cutting and laser cutting. Both of these have been around for many years in industry, but again, the arrival of Chinese



Diamond wheel is ideal for sharpening carbide tools.



Chinese plasma cutter requires just electricity and compressed air.



'Hobbyweld' – no rental gas cylinder on Mig welder.

made imports has made these relatively affordable. The plasma cutter, shown in **photo 10**, is a convenient alternative to the traditional oxy-acetylene 'gas axe'. This one cost just over £200, and easily cuts 8mm steel plate. Laser cutters seem to have reached the stage where they are affordable at the 40 to 50 watt power level, and these will happily cut cardboard, plywood etc. and can be used to engrave metal parts.

Where joining parts is concerned, the emergence of products such as the Loctite range have in many instances eliminated the need for accurate sizing for shrink fits. To over simplify, we can now have a 'rattling' fit and allow the adhesive to fill the gap. In the area of welding, brazing and silver soldering, it has probably become more difficult to have Oxy acetylene kit in a domestic environment, but Mig and Tig welding have grown in popularity. As a result, firms such as Hobbyweld have emerged and now provide gas cylinders with no rental contract, an attractive option for low rate users (**photo 11**). Silver soldering is still a much used process, however the solder compositions have changed (health and safety) and the old paraffin or petrol blowlamps have made way for propane torches. Model boilers here in the UK are typically either copper, silver soldered, or welded steel. However there seems to be a greater acceptance of welded stainless steel on the continent.

A process which effectively reverses our normal approach of machining material away is additive manufacturing or 3D printing. Variations on this theme have been around in industry for about 20 years, allowing complex metallic components to be produced by a combination of powder deposition and laser sintering. In the amateur setting, 3D printing has become affordable within the last 5 years or so, and parts can be made in plastic, either as finished items or to be used as patterns at the start of a casting process.

Materials

Our projects frequently require castings, and the major developments causing changes here, are the move away from traditional British manufacturing, the growth of internet purchasing, and the logistics that go with it. Being based near Perth, I can recall in the 80s, one local foundry, and several more within easy travelling distance. They have long since disappeared, along with several steel stockholders. My suspicion is that the economics of foundry work have also changed. I recently acquired four 6 inch diameter steel wheel blanks for the price of one casting. We are fortunate in having a number of material suppliers who are geared up to our small scale needs, who hold a wide range of materials, in many cases can offer a next day delivery.

Off the top of my head, most of the plastics I would use today have been around for many years. There are though a couple of notables. I tried using 'Fantastic Plastic' from Routout CNC which is supplied in pellet form and will melt at relatively low temperature (in boiling water) and successfully cast a complex internal shape. Carbon fibre emerged in the aerospace industry in the 70's, but with reducing cost, has more recently become popular in model aircraft and helicopter applications, where the high strength to weight ratio gives an advantage for highly stressed parts such as wing spars.

Models

The output of miniature rail enthusiasts working in the late 80s or early 90s was predominantly based on steam prototypes. Diesel or electric outline was less popular and in 7¼ gauge might be powered by a Briggs and Stratton or similar petrol engine. Bob Smith's well known Santa Fe loco on the Comrie track was a touch

and Kurt Schreckling). The Gas Turbine Builders Association was formed in the UK, becoming a coordination hub for the many developers and constructors. In due course, commercial production became viable, and advances in electronic control systems have allowed aeromodellers to fly 'real' miniature jets.

In more mainstream aeromodelling, the most significant change has been the shift from glow plug engines to electric power. Three developments have been taking place in parallel. Lithium ion and lithium polymer batteries have given energy storage density much in excess of the older nickel cadmium or lead acid types giving a weight advantage. Brushless motors have moved up to power outputs of several kilowatts, and matching variable speed controls have become commercially available. Alongside this, modern radio control operates on 2.4 GHz which does away with the old requirement for checking for frequency interference from other flyers. Camera carrying drones also have now arrived in earnest, and with the latest miniature gyro systems have become very much easier to control than the helicopters of just a few years ago.

Summary

There is much about our hobby which has remained unchanged. Take a cursory glance at a new manual lathe today and you will see the same major features as you would, 25, 50, or even 100 years ago. It will have a headstock, spindle, bed, saddle, cross slide, tool post, and tailstock. A similar comment may be made about milling and drilling machines.

Much though has changed, part driven by technological advances notably in electronics and computing, and part by the low cost and now high quality of Chinese output.

Silver soldering is still a much used process, however the solder compositions have changed (health and safety) and the old paraffin or petrol blowlamps have made way for propane torches.

larger, and used a Mini engine and transmission. Battery electric arrangements have become very much more popular, and this is particularly the case where kit built examples are concerned. These frequently utilise composite moulded bodywork. Suppliers of kit built locomotives have come a long way, responding to the demands of those who want a loco to drive, but choose not to spend money on a workshop and then countless hours machining parts to make their own.

In the field of miniature i.c. engines, designs have in some instances followed full size trends, incorporating overhead camshafts driven by toothed timing belts. Whilst it was well known back in the 60s that a turbocharger could be rigged to function as a gas turbine, work on miniature versions was stimulated by the publication of two books by German authors in the mid 90s (Thomas Kamps

Yet another factor is convenience. Electric flight does away with post flight cleaning of the oily deposits and, in a similar manner, railway enthusiasts can avoid waiting for steam and simply switch on and go. At the end of the run there is no cleaning the grate or the tubes, just recharge the battery.

A final thought, concerns the process by which MEW is brought together. I cannot speak for the very early days but, even around year 2000, most of the letters to Scribe a Line and a fair proportion of articles arrived in hand written form and thus needed typing into the computer. Several authors employed typewriters and sent hardcopy, which could be scanned, processed, then corrected. Due to slow internet speeds most material came in on floppy discs or CDs. Today, my guess is that virtually everything is transmitted by email. ■

On the **Wire** **NEWS** from the World of Hobby Engineering

New Tube Cutting Jig from Expo

I've had a chance to try out a neat little 'professional tube cutting jig' from Expo Tools. The jig has a v-block with 90 and 45-degree slots for a razor saw. A thumb-operated lever holds the work secure, and there is an adjustable stop with a laser-etched scale from 0-30mm. The whole thing is made from steel, including the nice solid handle. The handle can be unscrewed, which allows a tenon on the body to be used to hold the jig in a bench vice – the tenon is quite short, but I found it was far more than sufficient for cutting the sort of modest-sized material the jig is intended for.

I found the jig a pleasure to use with a razor saw for both brass and aluminium, and I'm sure it would also work well with plastic, balsa and hardwood sections. If you want to make a neat job of fine pipework this is a more convenient solution than a roller cutter and using a saw you get nice clean, undistorted ends. The jig costs £19.95 and, together with the Expo catalogue can be obtained at www.expotools.com



Chronos discount on Dasqua precision measuring tools

Readers who are quick off the mark can benefit from 10% off Dasqua tools until the 30 June at Chronos, who have become their new European distributor. Enter voucher code DAS100 (upper case) during checkout and they will apply a 10% discount to any Dasqua products in your basket. Please take care if paying with PayPal, you need to select PayPal from the drop down options rather than using the PayPal Express button to get the discount. www.chronos.ltd.uk

Making Wind Turbine Blades

I get a steady flow of press releases along the lines of 'Engineering College Opens New Building', however, from time to time I do receive some that I think may be of wider interest to readers. I recently heard from Norco Composites based in Poole in Dorset who had the challenge to make a tool for making wind-turbine rotor tips. The tool was designed with Blade Dynamics for their new 6MW offshore rotor assembly.

There were a number of design challenges which Norco had to overcome to produce the tool including the use of carbon fibre as a tooling material. This was overcome by carrying out a detailed thermal and structural analysis to ensure the support frame was able to support the tool throughout the rotational cycle of opening and closing yet not distort the mould during high temperature bake cycles. The tool is now CE approved and weighs 1.8 tonnes including frame and hinges.

If nothing else, I'm sure you will agree that the finished rotor blade is an impressive sight!



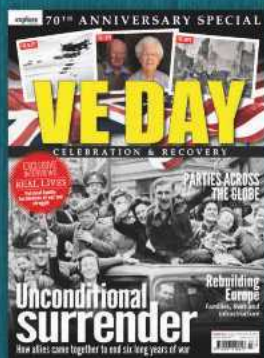
Above: Norco's moulding tool and, below, a completed blade.



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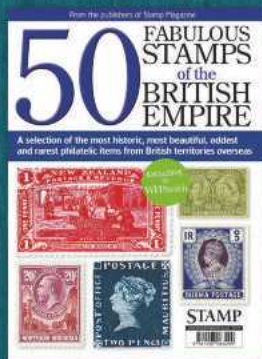
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■ Centec 2A Vertical/horizontal milling machine on stand with MKIII vertical head, single phase motor with reversing switch, collet chuck and vice, with some cutters £560 ONO cash on collection. **T. 01553 630429. King's Lynn.**

■ Colchester Student lathe comes with four jaw and three jaw chucks, fixed steady, 3-phase and single phase motor £300. **T. 01642 321357. Middlesbrough.**

■ Endmill sharpening device, simple system using cast aluminium parts and double ended bench grinder – built

with grinder ready to go! Full instructions does end and sides 1/4 inch to 1 inch diameter. £45 ONO. Buyer collects due to weight. **T. 01643 702750. Minehead.**

■ South Bend 4W1/2 inch swing, parts and accessories all new old stock most in maker's grease. Genuine items too many to list, phone for your requirements. Private sale hence reasonable prices. **T. 01784 462974. Staines.**

■ Axminster 918 lathe on cChester cabinet stand, 3-phase motor, 3-jaw chuck, faceplate, fixed steady, tailstock chuck, Myford thread, headstock handle, gear set, thread gearbox, very good condition £500. **T. 01256 473661.0 Basingstoke.**

■ Myford ML7B bench lathe, bench included. 3 and 4 jaw chucks, drill chuck, 7 inch faceplate, catchplate, fixed steady, centre, 4-way toolpost, leadscrew

handle, indexable dials, retrofitted countershaft clutch, 1ph 1/hp, Dewhurst and NVR switches. £750 OVNO. **T. 01642 886980. Stockton on Tees.**

■ Part machined parts for Myford division system. Comprises two castings linked by 12 inch hollow round bar, spindle bored MT2 with Myford thread on end and three threaded locking rings on the other. Also two division plates. £45 ONO. **T. 01642 886980. Stockton on Tees.**

Models Offered

■ 2-inch Clayton undertype steam lorry drawings, new £42 inc. postage. 7 1/4 inch Sweet William drawings, new £27 inc. postage. **T. 01776 700611. Stranraer.**

■ Adams Radial Tank 5 inch gauge complete set of profiled main frames. All hole positions punched, also laser cut

connecting rods and coupling rods £85 + p&p.

T. 01613 207754. Stockport.

Wanted

■ Is there a gearbox out there for a Myford ML7 at the right price; may be there's one rusting in a corner somewhere? **T. 028 71414529. Londonderry, NI.**

■ Part built locomotive, 5 1/2 inch or 7 1/4 inch gauge, any size considered. Private, old club member. **T. 01895 613919. London.**

■ Help! I have just acquired a 1:48 scale model of a G.R.A.B. handling mechanism which requires rather more than T.L.C. Can anyone provide me with plans, circuits or instructions please? **T. 01678 521066. Bala.**

■ Wanted Water Gauge, water level indicator, Maxitrack or similar. **T. 01727 864687. St. Albans.**

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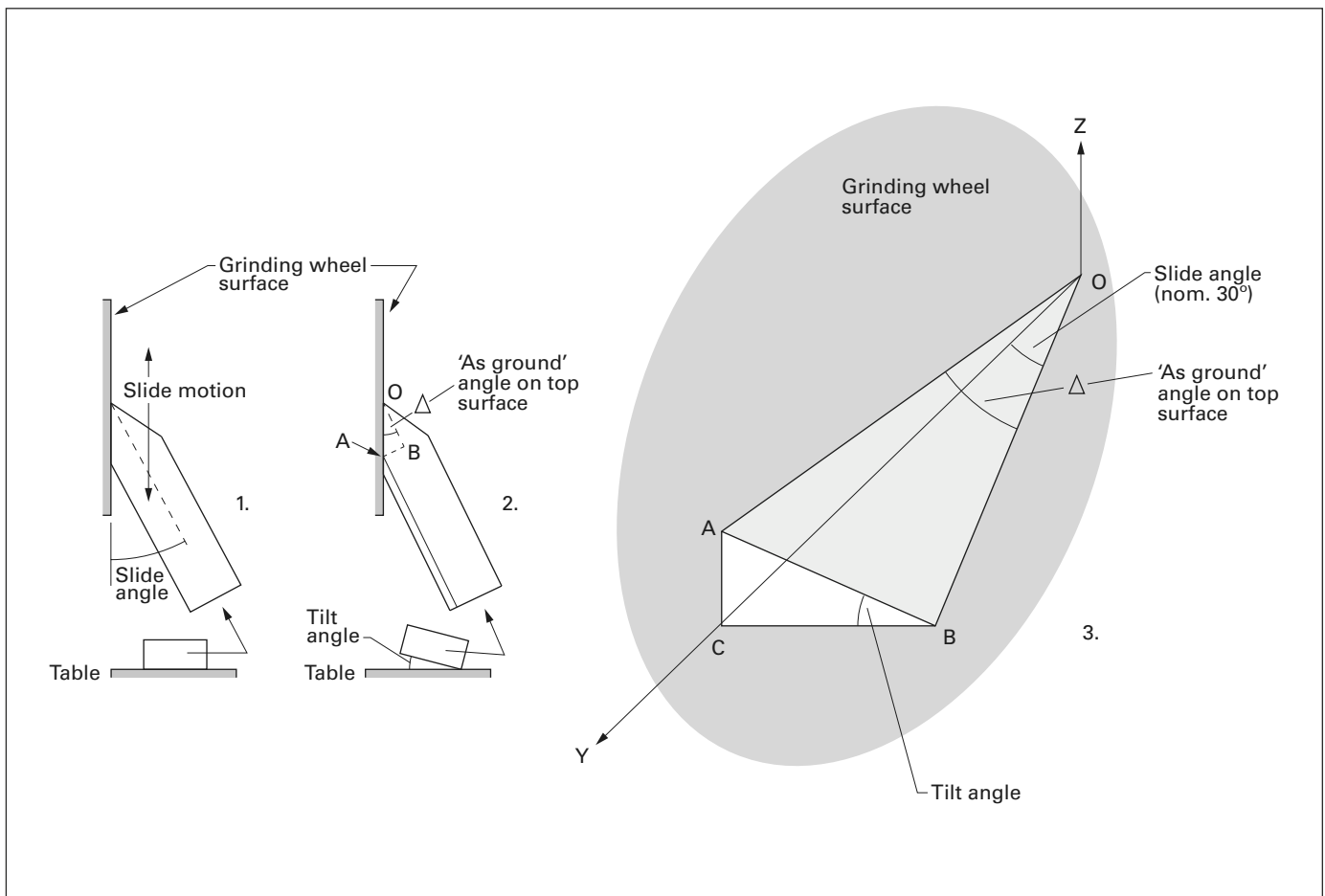
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Grinding a Single Point Threading Tool



Richard Rex takes a mathematic diversion for those who seek to cut accurate threads.



In the figure, the grinder table is assumed to be fixed at 90° to the vertical grinding wheel surface; tilt is achieved by rotating the tool about its long axis. If the tool is flat on the table (1), a slide angle of 30° will grind a half-angle at the tip of 30°. Flipping the tool over to grind the second face gives you the 60° included angle (Δ) for metric and US threads. (For Whitworth the corresponding angles are 27.5°+27.5° = 55°.)

But to provide the necessary side relief the tool (or the table) has to be tilted (2). This affects the included angle on the top surface – very little for relief angles up to 5°, but larger angles may noticeably affect the thread form. The questions are: exactly what is the error, and how to correct it if we need precisely 60°.

Wireframe model (3) imagines a slice OBC parallel to the table. OAB is the upper surface of the tool. C is defined by the vertical AC dropped from A, the rearmost, upper point of the ground surface. B is defined by AB, at 90° to the line OB representing the slide angle. This gives us two right angled triangles OAB and ABC from which we can determine the relationship between **tilt** angle, **slide** angle and Δ , the as-ground angle at the tip. From this we see that:

$$\tan \Delta = AB/OB$$

$$\text{and}$$

$$\cos[\text{tilt angle}] = BC/AB$$

Multiplying these expressions gives us BC/OB, but this is also the same as $\tan(\text{slide})$. It follows that the slide angle is:

$$\tan^{-1}[\tan \Delta \times \cos(\text{tilt})]$$

Similarly, Δ is:

$$\tan^{-1}[\tan(\text{slide})/\cos(\text{tilt})]$$

Two examples:

With slide angle 30° and tilt angle 10° the as-ground angle Δ is:

$$\tan^{-1}[\tan 30^\circ / \cos 10^\circ] = \tan^{-1}(0.577 / 0.985) = 30.4^\circ$$

For Δ to be exactly 30° with a tilt angle of 10°, the slide angle has to be:

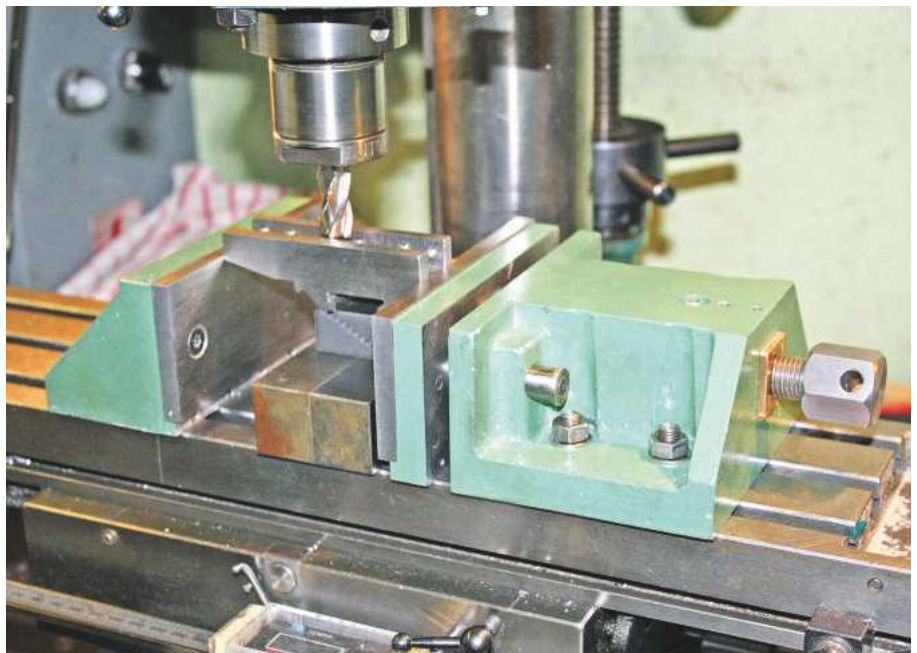
$$\tan^{-1}[\tan 30^\circ \times \cos 10^\circ] = \tan^{-1}(0.577 \times 0.985) = 29.6^\circ$$

A Table Length Milling Vice



In this series, with beginners in mind, David Piddington gives a step-by-step guide to machining a milling table vice of his own design. The castings and full size drawings for the vice are available from Hemingway.

The original concept of this vice was taken directly from similar commercially available ones which are too large for model engineers like myself who only have workshop space available for lathes such as the Myford Series 7 and smaller mills such as the Senior 'E', for which the two prototype vices were made. My own workshop measures 11½ by 7½-feet so storage and workspace comes at a premium.



The currently available larger commercial vices are sold in two varieties. One has a standard screw clamp with full retraction, and the other has a quick release, which operates, I assume, with a helix. As I do not have the tooling to machine a helix, the vice offered here does not retract the grip with the clamp screw though it will release the pressure. An additional careful hand movement to the 'loose' jaw carrier will be required to retract it having loosened the grip to remove and replace work pieces.

I made two units. One for myself: and the other for Hemingway Kits to display on their exhibition stand and to whom I had offered the design in exchange for two of each of the castings required. I am grateful for permission to use what are now their copyright drawings with this series as they have been 'computerised' from my portable 'Tecnostyle 620' 17½ x 13¾ inch drawing-board-with-protractor and pencil drawings.

It will also be noted from these that the larger casting has been 'slimmed down'. It will later be seen from the accompanying digital images that some 'awkward' machining was required to put in the four bolting down holes. This modification, together with a larger underside pocket,

will also require less metal in the casting though whether this will have a benefit in the actual cost is beyond my control.

It is feasible that the design can be adapted with suitably spaced bolt holes, or bolt slots to fit other similarly size milling machines. It is regretted that actual dimensions for these are not available to me.

Imperial inch dimensions are given in the text, as this is the designer's preference. Having almost completed this manuscript and offering it for publication, in discussion I was prompted as to the measurement system to be used in print. As an encouragement to the late 20th and early 21st century's beginners and young engineers it was thought that the best would be metric which I agree with in part. However as a mid-to late 20th century engineer educated and trained with the Imperial inch system that I still use, I propose not to attempt compromise by converting these instructions to metric giving 'awkward' dimensions.

Therefore I ask your consideration that as it is customary for schools to encourage pupils learning an additional language to the native tongue – our UK students often learn French, perhaps German, or both - it

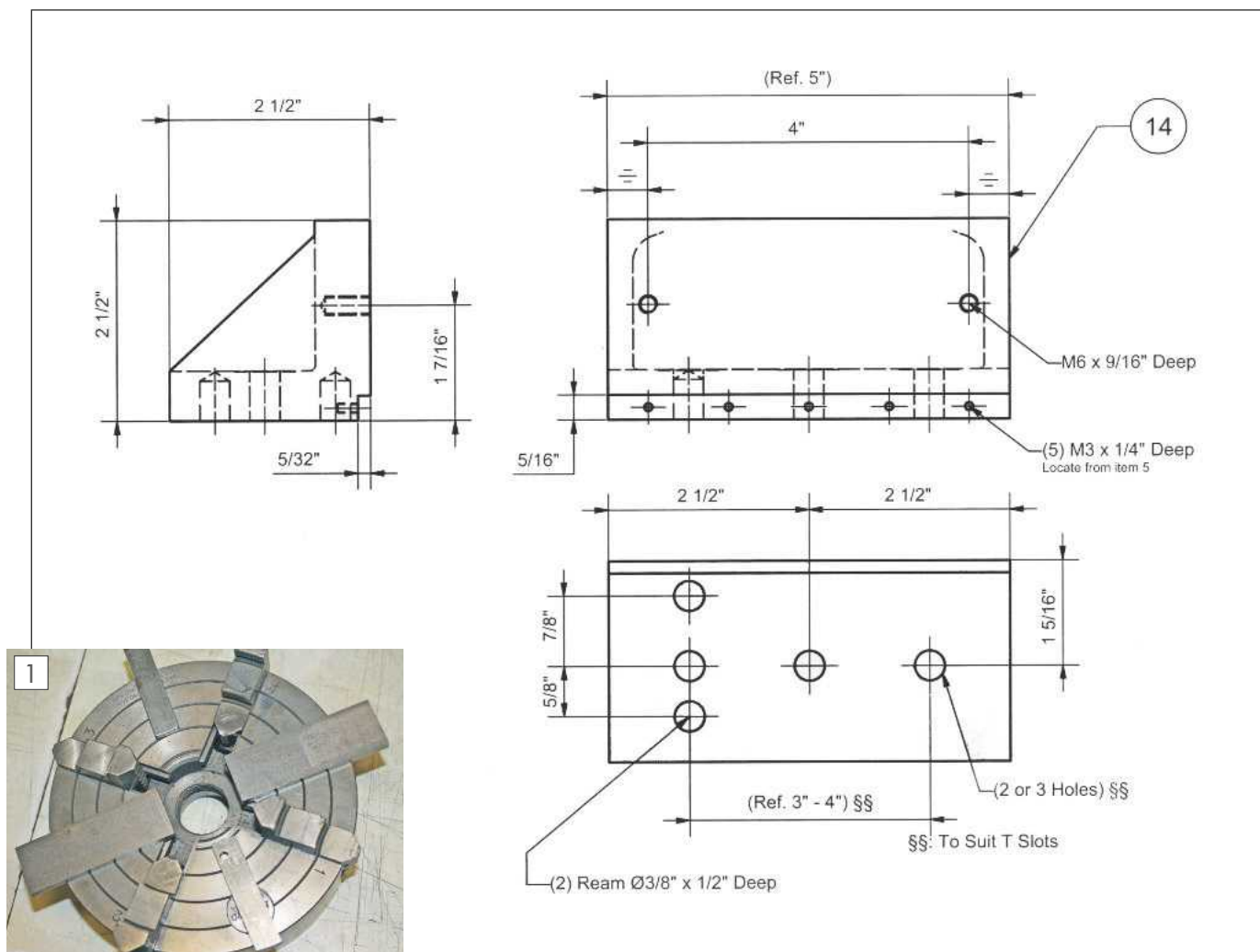
is appropriate to learn feet and inches with decimals and fractions, as well as metres and millimetres, which I have also seen with fractions, as both are simply different *languages of measurement*! One suits the trained user. Others can learn the alternative. Incidentally my Casio AZ-45F Pocket Calculator is a valuable aid for calculating in fractions and then converting to decimal as and when required. I would not like to be without mine.

Machinery used

- 1) Senior 'E' milling machine, with 4.5/8 inch wide table, 15 inch 'x' axis travel and 5 inch 'y' axis travel. This machine with its column keyway is capable of jig-boring to accuracy. The ubiquitous 'mill drill' usually cannot do this.
- 2) Myford Super 7B lathe with standard length bed and power feed cross-slide.
- 3) Bench drill ¾ inch capacity (Martin Cleeve *Model Engineer* design of 1967).

Special tools required:

- a) 23/32 or 47/64 inch diameter drills to pre-bore for (b):
- b) ¾ inch diameter reamer, machine or hand.



- c) Between-centre boring bar $\frac{5}{16}$ inch diameter approx 12 inches long with tool at centre – to substitute for $\frac{3}{4}$ inch diameter reamer if this is not available.
- d) Boring head, adjustable type with suitable drawbar for your lathe headstock spindle. This may also be used in your milling machine assuming suitable taper adapters are to hand.
- e) 90° countersinks $\frac{1}{4}$ and $\frac{1}{2}$ inch diameter.
- f) Taper and 2nd and/or plug taps, and split die, $\frac{5}{16}$ inch BSF preferably HSS for better accuracy, or for whichever thread size you adopt for the clamp screw.
- g) Taps for $\frac{1}{4}$ inch BSW, or for M5 alternative.

Also the variety of machine tooling and hand tools usually part of a basic workshop.

Makers of this vice with other machinery to the above will have to adapt

to suit their facilities. It is suggested that a minimum 3 inch centre height lathe with cross slide travel of 4 inches on a slide length of 9 inches for clamping purposes will be required if your machine is to be used for boring the sliding jaw and its carrier.

For securing this vice to the machine table it is recommended that bolts of not less than $\frac{5}{16}$ inch BSW or BSF, or 8mm x 1.25mm pitch be used. I have used the abbreviations PGFS - Precision Ground Flat Stock (Gauge Plate) and FCMS - Free Cutting Mild Steel.

The figures and images are not necessarily in chronological order, or that of the Parts List on the Hemingway drawings set. It is advisable that holes in the fixed and clamp blocks, and for the vice jaws, be co-ordinate marked and drilled from the centreline, not from the edges of the castings.

Photograph 1: The 4-jaw independent chuck with $\frac{3}{16}$ inch packing blocks between chuck jaws ready to accept the fixed jaw. Note that one pair of opposing chuck jaws are set for outside grip and the other pair for inside grip.

Photograph 2: Close-up showing gap at back of casting when the support blocks have been removed. Removal is necessary to avoid injury as these can fly out when the chuck revolves. **Photograph 3** shows the initial cut under way.

Photograph 4: Initial setting of the fixed jaw in the 4-jaw chuck. Note that it is the vertical part of the casting that is being gripped to machine its bottom face.



Photograph 5 shows a copper insert between casting and inside curve of chuck jaw.

Photograph 6: Checking that the fixed jaw casting stays vertical to the chuck while the balance weights are secured by tightening their adjacent chuck jaw. There was a 'lump' of casting in the middle of this face area that had to be removed/filed away so that the weights could grip securely over the maximum area.

Photograph 7: Commencing to machine the bottom face of the fixed jaw. The chuck jaw opposite the balance weights can now be seen holding the inner casting face.

Mill table T-slots usually have a chamfer where the slot side meets the working surface. There is no guarantee that your setting bar will be in the exact centre of the slot as it rests on the vees.

Photograph 8: Setting for the initial clamping holes in the fixed block. Using a wiggler or centre finder (**photo 9**) from a suitable diameter bar in the centre tee slot of the mill table (or another if you don't have a centre one) locates the exact centre of the slot. To do this from the micro-dial or read-out move the 'y' axis a further half the diameter of the setting bar to locate its exact edge, and then a further half of its diameter to locate the exact centre. Now centre your micro-dial or read-out to zero. The location points of the outer tee slots may be located by winding the 'y' axis plus or minus the amount.

Mill table T-slots usually have a chamfer where the slot side meets the working surface. There is no guarantee that your



setting bar will be in the exact centre of the slot as it rests on the vees. However provided that subsequent moves of the 'y' axis are to the exact slot centres, there should be no further problem in use of the finished vice. The tee-slot centres on my mill, the Senior 'E', are set at a nominal of 1.½ inches.

Photograph 10: Now set the fixed jaw with machined face down on the mill table and centralise it as in this photo. At the same time set it square across the table and secure with clamps as in the next photo.

Photograph 11: Next, with one of your standard clamping washers, set this on the upper surface just touching the edge of the corner radius and estimate by moving the table's 'x' axis until a centre drill is approximately in the middle of the washer's hole. It is probable you will need an extra-long centre drill that is available commercially, but for just three holes this is an extra expense. An extended drill is



easily made by drilling a short length of bar to a suitable depth for the chosen drill and fix using high-strength 'Loctite' and allow to cure. A brass bar cures the 'Loctite' quicker than a steel one.

Photograph 12: At these settings the holes may now be drilled up to the same size as your table clamping bolts. I recommend not drilling a clearance size at this stage, AND importantly do not drill right through at finish size. Do this later on your drilling machine just in case you've made an error. Machine marks on the mill table are 'for all time' witnesses to carelessness. There are two such witnesses on my machine. Finish size holes will also assist the next machining stage. If it is desired later, these holes may be extended into slots. The scenario for this would be if the completed vice were to be used on a much larger machine table.

The original intention was to use standard Myford tee-bolts but due to insufficient clearance for a spanner on the nuts – due to the casting being a bit too wide, I decided to adopt ⅝ inch BSF tee nuts with studs. A smaller size – ¼ inch



BSF - is used on the Hemingway display unit. Other machine owners please modify dimensions as required.

Photograph 12A shows the initial setting of the fixed jaw in order to spot face the bolt-holes. Align with a same size diameter bar as your drilled hole, as shown with the casting against a fixed bar (see images 15 and 16 below) and securely clamp. This hole may now be spot faced, see **photo 12B** and, as we know the centre distance between the holes, the table may now be indexed appropriately for the other holes. I had to move the clamp, as my camera's self-focussing insisted on using that and not the cutter. It will be noted that a 3-jaw chuck was used to hold the $\frac{3}{4}$ inch diameter slot drill, as a long reach cutter was not available.

Should you be adopting slots instead of holes for bolts, the upper faces should be lightly milled instead along the slot length.

Photograph 13: A means of securing the fixed jaw to the mill to machine the adjacent face at 90 degrees. Over the years I have acquired three angle plates, one of which was initially devoid of holes and to which I have created a few for 'specials' like this. Photo 13 shows the fixed jaw G-clamped to this angleplate that is already secured at its rear to the mill table. I shall leave it to the reader's imagination and not having an extra arm and hand to take a photo, with my battery powered hand drill I spotted through the two $\frac{3}{8}$ inch outer holes of the block into the angleplate.

As shown in this photo, the fixed jaw is set with its to-be-machined-face above the angleplate. Mine was set too low and should be set approximately $\frac{1}{4}$ inch above the top of the angleplate. (See later photo 20 where I overcame the problem).



Photograph 14: Shows the indents left by the $\frac{3}{8}$ inch drills, which are now opened up, in the drilling machine. If desired, these holes may be tapped later and plugged.

Before commencing any machining it is necessary to set the angleplate exactly parallel to the 'x' axis as this facility will be required later. To do this I use a long tenon strip made from $\frac{3}{8}$ inch by 1.1/2 inch steel, which is slotted at both ends and tapped at an angle to take a taper-headed socket cap screw to expand the side and grip inside the slot. This accessory is very useful for temporary clamping work to it, especially wood and plastics. The angleplate is held against it with identical packing blocks at each end, if required on your own set-up, and bolted to the table. See **photos 15, 16 and 17**.

The fixed jaw casting may now be bolted to the angleplate making sure that a minimum of $\frac{1}{4}$ inch remains above the top edge. My own was less than this, though adequate, and can be seen in images 18 and 19.

Photograph 18: Some time ago a local tools supplier was offering in his monthly 'special prices' lists one of those indexable inserted tool tip flycutters and, while it was



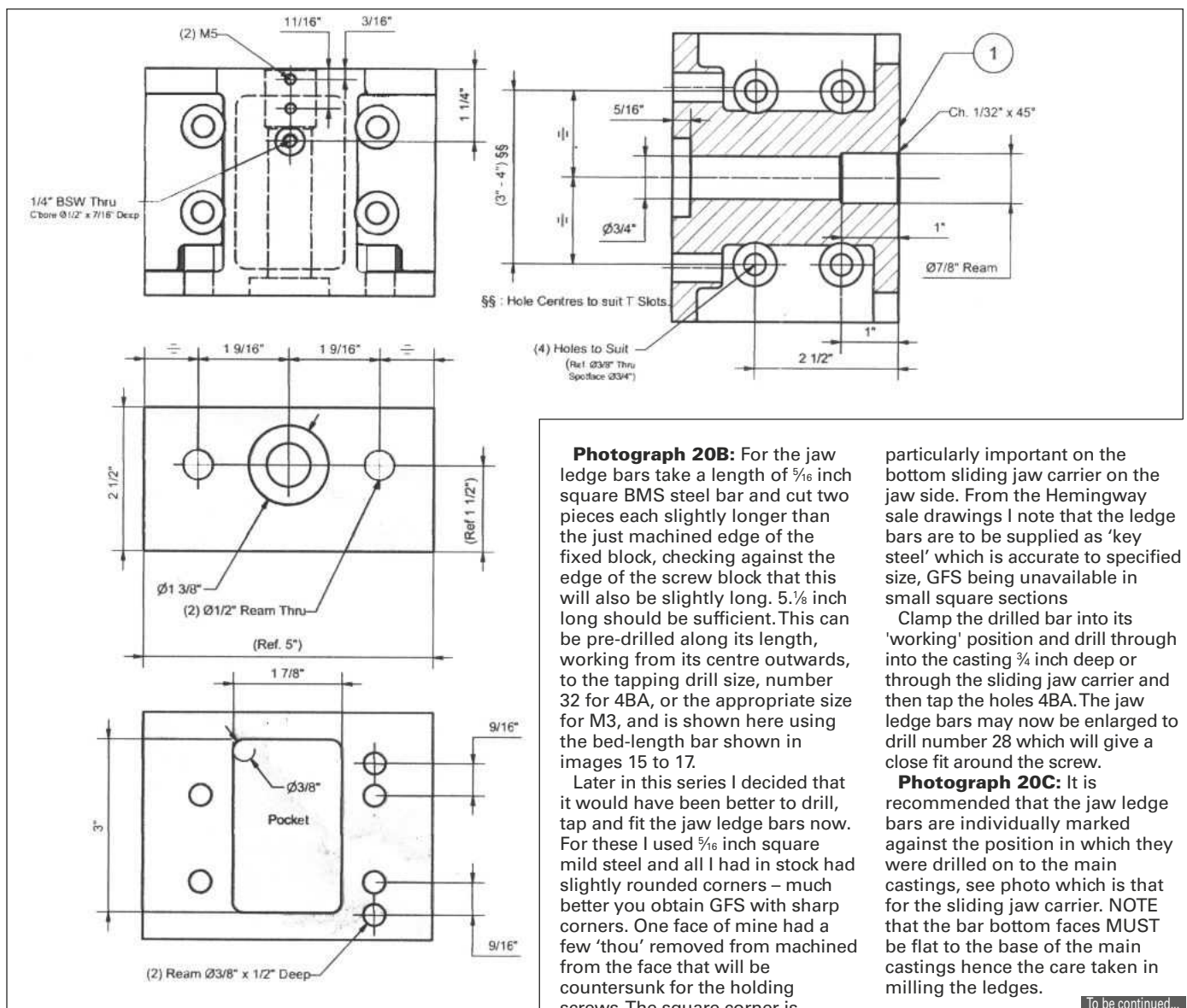
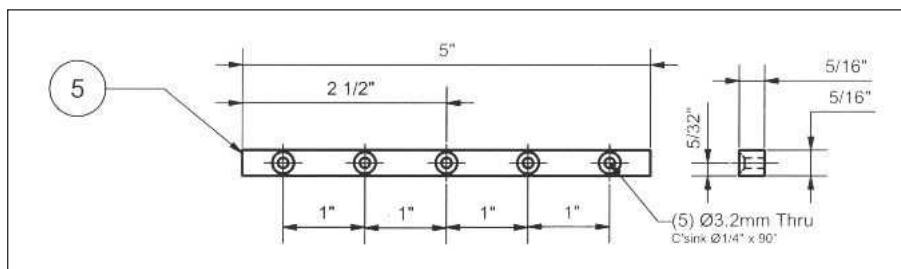
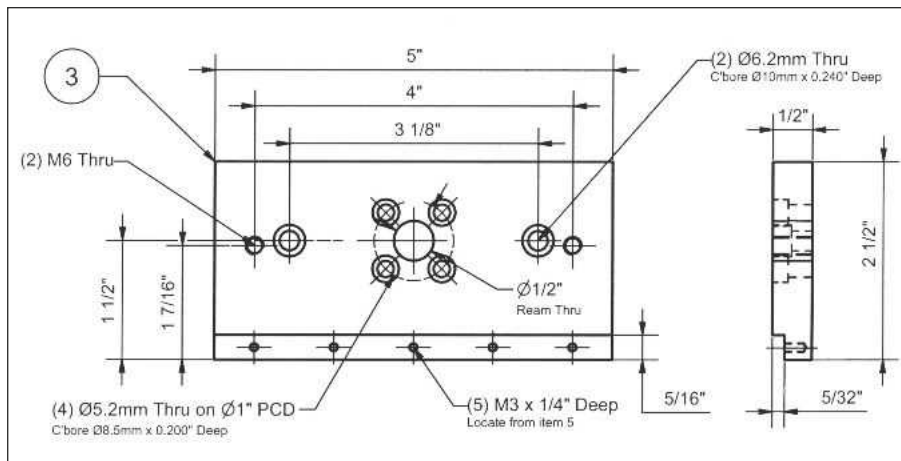
expensive it was not in that not-justifiable price range that makes dinosaur pensioners like me turn away. However I found I was only able to take light cuts with it, no more than five thou' at a time.

Photograph 19: A not unreasonable surface resulted. I found that carbide tipped tools were essential to get under the hard skin of the casting.

Photograph 20 shows the method of measuring the step indicating that more metal has to be removed. Accurately measure its size and mill into the edge of the fixed jaw half the bar thickness, 0.1563 inch, and to its full size so that the bottom of the bar and bottom of the block are level to each other.

Photograph 20A: This photo shows the similar machining of the ledge on the sliding jaw carrier.





Photograph 20B: For the jaw ledge bars take a length of $\frac{5}{16}$ inch square BMS steel bar and cut two pieces each slightly longer than the just machined edge of the fixed block, checking against the edge of the screw block that this will also be slightly long. $5\frac{1}{8}$ inch long should be sufficient. This can be pre-drilled along its length, working from its centre outwards, to the tapping drill size, number 32 for 4BA, or the appropriate size for M3, and is shown here using the bed-length bar shown in images 15 to 17.

Later in this series I decided that it would have been better to drill, tap and fit the jaw ledge bars now. For these I used $\frac{5}{16}$ inch square mild steel and all I had in stock had slightly rounded corners – much better you obtain GFS with sharp corners. One face of mine had a few 'thou' removed from machined from the face that will be countersunk for the holding screws. The square corner is

particularly important on the bottom sliding jaw carrier on the jaw side. From the Hemingway sale drawings I note that the ledge bars are to be supplied as 'key steel' which is accurate to specified size, GFS being unavailable in small square sections

Clamp the drilled bar into its 'working' position and drill through into the casting $\frac{3}{4}$ inch deep or through the sliding jaw carrier and then tap the holes 4BA. The jaw ledge bars may now be enlarged to drill number 28 which will give a close fit around the screw.

Photograph 20C: It is recommended that the jaw ledge bars are individually marked against the position in which they were drilled on to the main castings, see photo which is that for the sliding jaw carrier. NOTE that the bar bottom faces MUST be flat to the base of the main castings hence the care taken in milling the ledges.

To be continued...



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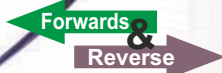
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Flexible Coolant Hose Pliers



Have you ever struggled with a segmented coolant hose? Laurie Leonard has the answer.

Introduction

The multi-segmented flexible coolant hose has found its way into most workshops and I use it both on the lathe and the milling machine. Picture this: the job is set up in the mill and thought is focused on the first cut. Better just set the coolant nozzle to dispense at the cutting point (**photo 1**). Over adjust the nozzle and a piece of the pipe comes off in the hand. Fumble, fumble, curse, curse as effort is made to fit it back on. Now if only there was a tool to make the job easy. There is but one was not to hand and the situation had occurred so often that the time was now to sort it but how?



Flexible coolant hose in use on a milling machine.



Circlip pliers.

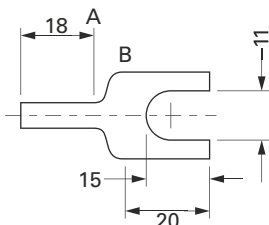


New tips for use with coolant hose.



New tips fitted to circlip pliers.

Fig. 1



Notes:

1. 1/2in O.D. 0.8mm wall tube used
2. A & B are positions where tube was crimped in the vice (crimps at right angles to each other)

Tip

Description

To force the segments of the hose together some sort of pliers are required. A basic 'scissor' arrangement could be made from mild steel strip but as there was a job waiting in the mill an alternative was sought. In my collection of tools I had a pair of circlip pliers which accommodated interchangeable points (**photo 2**). Could these be adapted to carry tips to close the coolant hose joints?

The new tips required to be of sufficient strength to force the pipe segments together and be easily fitted to the pliers. A length of half inch OD tube was to hand and two pieces were cut off. The tube was

crimped twice in the vice at points shown in **fig. 1**. The crimps were made at right angles to each other. Holes were drilled as indicated and opened up to slots to accommodate the pipe segments resulting in the new tips as shown in **photo 3** and mounted on the pliers in **photo 4**. A suitable hole was drilled in the new ends to secure them to the original pliers utilising the point retaining screw.



Close up new tip showing dished claw.



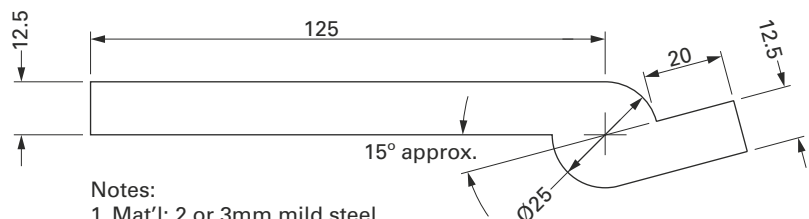
Modified pliers in use on flexible coolant hose.

To prevent the pipe segments shooting out of the slots in the claw tips when under the pressure from the pliers, the newly formed claws were dished as can be seen in **photo 5**. **Photograph 6** shows the modified pliers in use on a length of coolant hose.

Conclusion

The above work enabled a pair of circlip pliers that were to hand to be used to close segments in flexible coolant hose. Although the description above is specific to the pliers in hand it can be adapted for others that may be available or a simple scissor arrangement constructed from mild steel strip to accommodate the tips could be made as suggested (but not made and tried) in **fig. 2**. As is often the case, the design utilised materials to hand and changes can be made to accommodate other material to hand.

Why did the pipe part company in the first place, necessitating the construction of the pliers? My first thoughts were directed at my ham fisted approach when



Notes:

1. Mat'l: 2 or 3mm mild steel
2. Two pieces req'd
3. Radius all sharp corners
4. Short end may require shaping to accept the tips
5. Suggested pivot: 3mm set screw with nyloc nut adjusted for free movement with no slop

Simple Scissor

Fig. 2

performing the adjustment but later I found that, over time, a deposit had formed around the ball joint on each segment which effectively glued it to the next segment. Breaking this bond resulted in a jolt to the pipe and segments coming

apart. The pipe was taken apart, segment by segment, and cleaned. After reassembly it was much easier to position the nozzle where required as the ball joints were freer but there are still occasions when the tool is required. ■

In our Next Issue

Coming up in issue 231

On Sale 17th July 2015



Designed by CAD

Paul Lousick details his Morse-taper removal tool.



New Lathe Review

The new Warco WM250V and its milling attachment reviewed.



Assorted Adepts

Howard Lewis reports on a gaggle of vintage lathes seen at the Spalding Show.

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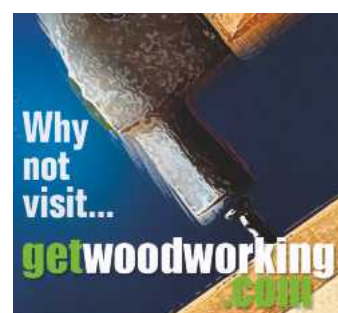
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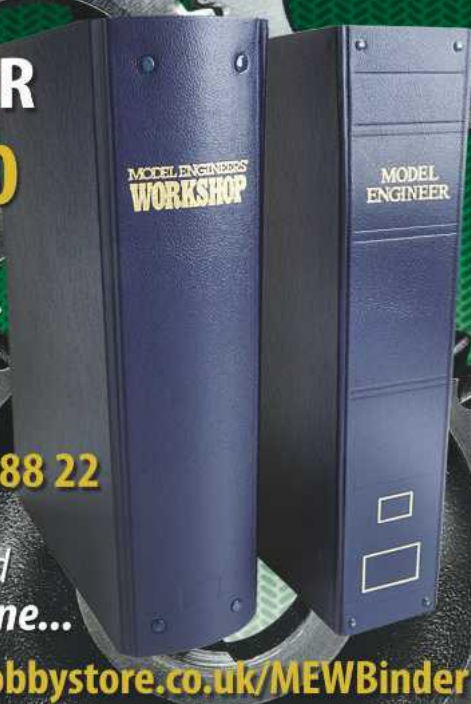
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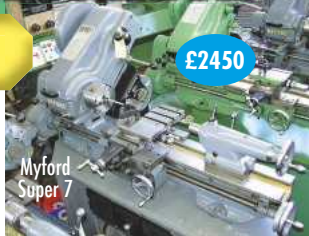
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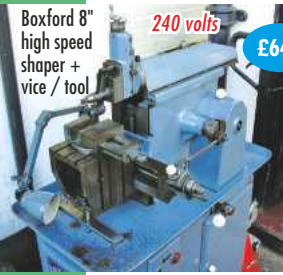
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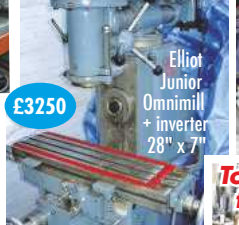
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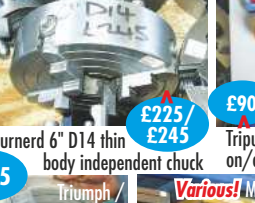
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